DRAUGHTSMANSHIP

R. FRASER REEKIE

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By the same author

DESCRIPTIVE GEOMETRY FOR ARCHITECTS AND BUILDERS

PRACTICAL GEOMETRY FOR JUNIOR BUILDERS
(with L. A. LEE)

DRAUGHTSMANSHIP

by

R. FRASER REEKIE

Dip. Arch., F.R.I.B.A., Dip. T.P., A.M.T.P.I.
R.I.B.A. Bossom Gold and Silver Medallist
R.I.B.A. Grissell Gold Medallist

Formerly Instructor in Draughtsmanship, Lecturer in Design and Construction, The Polytechnic School of Architecture, Surveying and Building, London

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AUTHOR'S PREFACE

THE purpose of this book is to describe the technique of draughtsmanship and the methods of preparing drawings used in connection with the lay-out, design, and construction of buildings.

It is written mainly for the student, particularly the beginner, but it is also intended as a reference book for the more accomplished.

For several years I have been concerned in the teaching of draughtsmanship, and I have discovered that anyone with normal vision and the ability to use his hands intelligently can be taught to draw very well in a short time. The only people who never learn to draw or who draw badly, apart from those with some physical handicap, are those who are not interested —although how anyone can fail to be interested in drawing, especially if proposing to take up or actually engaged in work connected with building, is difficult to understand.

However, while it is true that no one can learn to draw by reading a book and that the real way is to start drawing and to keep on drawing as much as possible, the process can be made a good deal easier by knowing the methods which up to the present have been found successful; and the various conventions in common use. But I am not a lover of unnecessary standardisation and I would not like to see all draughtsmen producing exactly similar drawings. Therefore, while I have tried to include what I believe to be the most useful information and advice, I have deliberately besprinkled the text with such qualifying words and phrases as "usually", "generally", "in most cases", and so on, with the intention of avoiding any feeling that draughtsmanship is a matter of hard and fast rules. Such a belief, simpler though it might make life in some respects, does not give rise to satisfactory work, and I strongly emphasise the suggestion made frequently throughout the book that only by the continual study of drawings of all types, non-technical as well as technical, and by experiment and practice can first-class proficiency be achieved.

Of course, the broad principles of good drawing are unchanging: suitability in accordance with purpose, accuracy, legibility and neatness, economy in time and labour; but there are always opportunities for new and better ideas in satisfying them, especially with regard to architectural renderings. Let the beginner, however, be in no hurry to impart a personal "style" to his work—it may result in mere eccentricity and

affectation. A good foundation, the habit of simple, direct drawing, should be laid first. Real individual character comes with practice and cannot be forced.

I have assumed that readers, whether or not attending classes or receiving practical experience in their profession, are in a position to study other subjects and have an elementary knowledge at least of some of the common terms used in building. Most of them used in this book will, I think, be clear from the context, but any doubtful ones should be looked up in an appropriate technical dictionary. The study of geometry and geometrical drawing should in particular proceed concurrently with the study of draughtsmanship, and for this reason I have not dealt with the working out in detail of the examples included here.

I have been greatly assisted in the preparation of this work by suggestions and criticisms from my colleagues and professional associates and, not least, by the successful and not-so-successful efforts of my students. I also wish to express thanks to those who prepared drawings specially or who loaned drawings for inclusion in the examples illustrated and whose work is acknowledged individually elsewhere, and to J. D. W. Ball, Esq., of the British Standards Institution, and Harcourt Hanrott, Esq., of the Drawing Office Materials Manufacturers and Dealers Association.

R. Fraser Reekie

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CHAPTER I

DRAWING EQUIPMENT

THE following notes deal with the principal items of drawing equipment required by the student and the draughtsman.

There are many different kinds of most of the articles mentioned. A full description of all would be tedious and is unnecessary. The aim here is to cover everything essential and to give guidance as regards general selection and use.

The beginner is advised to purchase the best available instruments that he can afford; the experienced draughtsman usually requires no such reminder. While it is possible for the latter to make good drawings with very little or even improvised equipment when the occasion arises, it is foolish for the novice to handicap himself at the outset by inadequate or inferior articles. It is also advisable to purchase equipment from reputable drawing-office material manufacturers and dealers.

Drawing Boards

Drawing boards are made in sizes to correspond with drawing paper sizes. The most common for general use are:

Half Imperial	23×16 inches
Imperial	32×23 "
Double Elephant	42×29 "[1]

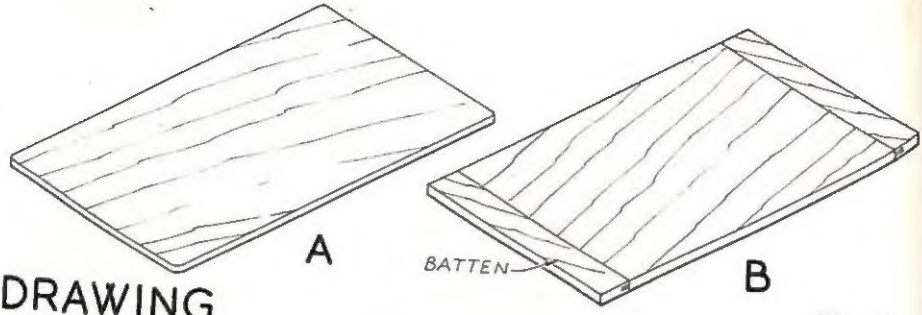
"Antiquarian" boards, about 54×32 inches, but sometimes bigger, are used for very large drawings. Boards can be specially made to any size.

Fig. 1 illustrates three types. A and B, not bigger than imperial, are suitable for the student as they are comparatively light for carrying about and are inexpensive; C is best for office use.

Type C is manufactured from selected pine and has hardwood battens with brass slots, to allow for expansion and contraction, at the back, which is also grooved to resist warping. One edge of the board has an inlaid ebony strip as a guide for the head of the T-square, Fig. 3.

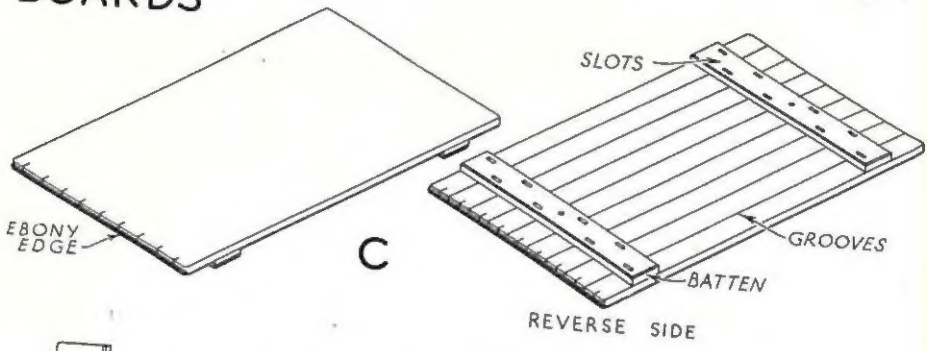
It is important with all types of drawing boards that they are perfectly flat and smooth, and will not twist or warp with normal use. The edges should be at right-angles to one another. The surface should have a firm, even grain, free from knots and be soft enough to take drawing-pins easily.

[1] The British Standards Institution recommend that this size should be increased to 42×32 inches to take the 30" size of roll paper (see pp. 19 and 21).



DRAWING BOARDS

Fig. 1



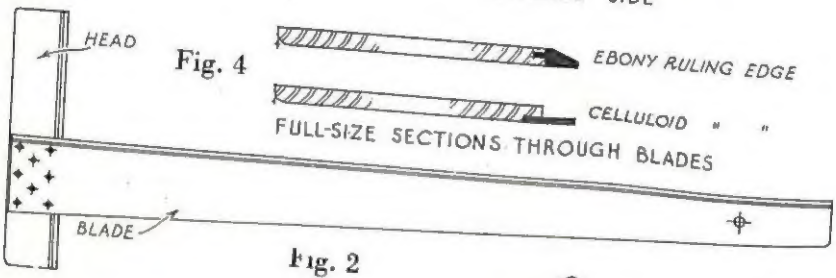


Fig. 4

Fig. 2

T-SQUARE

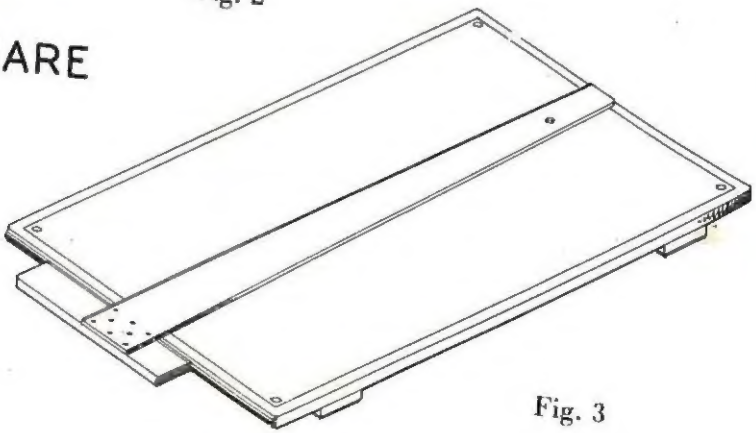


Fig. 3

Care of Drawing Boards

The value of a good drawing board can only be maintained by careful treatment. The surface should be protected from knocks and scratches. If left on the table, it should be covered with a cloth; if put against a wall the working side should face inwards and the ebony edge should be at the top. It should not be exposed to heat or moisture. Drawing pins should not be stuck in unnecessarily, and using the board as a backing on which to cut paper or card is harmful to the surface.

T-Squares

T-squares, Fig. 2, are described in shape by the name. They are used in conjunction with the board for drawing horizontal lines, Fig. 28, the head of the T-square being held against the left-hand side of the board.

Sizes correspond to the lengths of the drawing boards referred to above:

Half Imperial	24″ blade
Imperial	31″ ,,
Double Elephant	42″ ,,
Antiquarian	54″ ,,

Care should be taken in purchasing to see that the blade is the full length.

T-squares are best when made of mahogany with ebony or celluloid ruling edges, Fig. 4. Hardwood (pearwood, maple) T-squares with bevelled edges are cheaper and while satisfactory in the smaller sizes for student exercises they soon become worn and tend to warp.

In England, the blade usually tapers, which makes the T-square more manageable when lifted by the head. In the U.S.A. and on the Continent the blade is more often with parallel edges. They have necessarily to be made of thin strips of wood for lightness, but this renders them liable to fracture. They should therefore be handled with care and should not be left lying about in "bridging" positions or leaning against walls. They should either be left flat or hung on pegs. Damage is also likely to arise in two other ways by careless handling: a loosening of the fixing between head and blade, and indentations along the ruling edge. The former results from using the T-square as a hammer with which to knock in drawing pins!; the latter by using the blade as a straight-edge in cutting paper. Loose blades can often be tightened up with a screwdriver, but care must be taken to see that a true right-angle is formed with the head. Blades that have become dented can be re-shot; a remedy which

should not be attempted by the amateur. Most drawing equipment suppliers will carry out this and other repairs.

It is important to keep the underside of the blade smooth and clean, and this is best achieved by wiping it periodically with a soft cloth and a few drops of petrol or similar spirit. Water can be used, but is less effective and may cause warping. The underside is less likely to collect dust in traversing the paper if the tapered edge is rounded off, as shown in Fig. 4.

Set-Squares

Set-squares are used for drawing vertical and inclined lines. They are triangles of celluloid about $\frac{1}{16}''$ thick and are of three kinds, as illustrated in Fig. 5: A—45 degrees, B—60–30 degrees, C—adjustable.[1] The last supersedes the two others as it can be set to any angle. Mahogany and ebonite were formerly used for set-squares, but these materials not being transparent, are more or less obsolete.

For general use, the length of the longest side should be about 9″–12″ (sizes range from 4″ to 18″), and the edges should be square, Fig. 6, not bevelled. The square edge is less likely to cause smudging when ink lines are ruled.

A type of set-square specially designed to prevent smudging is illustrated in Fig. 5D.[2] It consists of the ordinary type of celluloid set-square with additional thin celluloid strips stuck on both sides a short distance back from the edges which are thus raised above the paper.

As with T-squares, it is important to protect set-squares from damage. Dents are caused by hard knocks, and cutting with a razor-blade, etc., along the edges can easily ruin them. They should be kept scrupulously clean because dirty set-squares quickly transfer the dirt to the drawing in almost ineradicable lines and patches. Petrol, etc., can be used for cleaning, but soap and water is also effective and does not harm celluloid. Particular care should be paid to cleaning the edges of set-squares.

Drawing Instruments

Chief amongst the personal equipment of the draughtsman is a set of instruments, and special attention should be taken in the selection and care of them. There is normally a wide range of kinds and patterns to choose from, and they can be bought separately or in sets. It is probably more economical to purchase the pieces individually in the beginning. Sets, in cases, usually contain one or more inessential items, and it is probably

[1] There are various patterns. The one illustrated is based on the new "Facila" Adjustable Set-square.

[2] The "Uno" non-smudge set-square.

SET-SQUARES

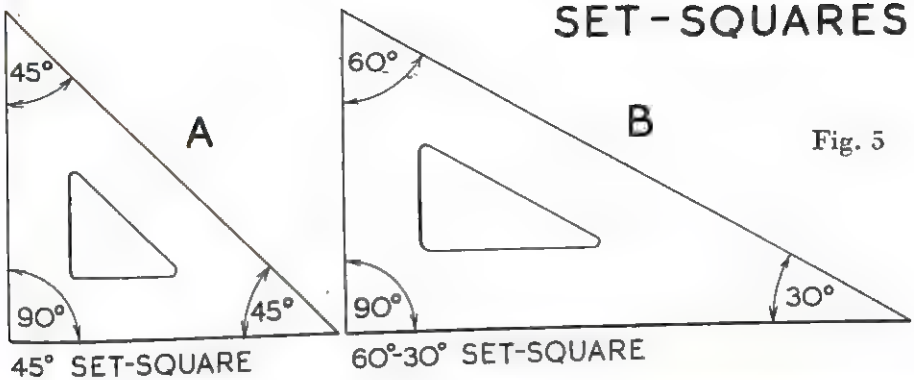


Fig. 5

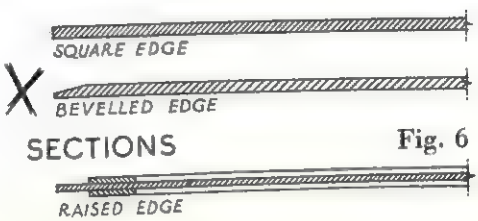


Fig. 6

easier to test the instruments if they are bought singly. Cases are, of course, useful for keeping the instruments, which require to be protected when not in use. A suitable carrying-case can be made cheaply, however, by folding and sewing a piece of chamois leather to form a series of pockets. This can be folded up and tied with tapes.

The most useful types of instruments described below are based on good typical examples, usually made in electrum.

All instruments should be carefully examined to see that they function properly. Needle points of compasses and dividers, ruling pens and pen compasses should be checked.

Dividers

Fig. 7 illustrates a pair of dividers used for dividing lines into equal units by trial and error and for multiplying or transferring distances. A convenient size is about $5\frac{1}{2}$" long. A spring screw attachment to one leg for fine adjustment is an advantage. The hinge should move easily but should not be loose.

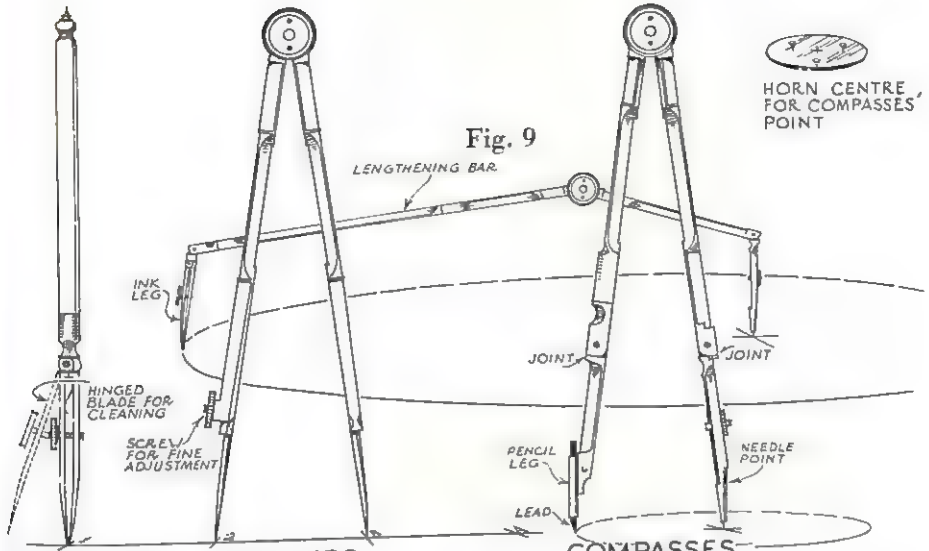
Compasses

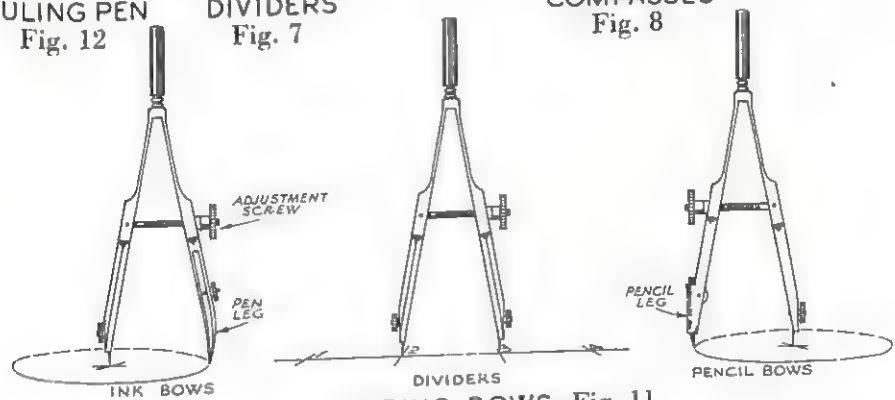
Fig. 8 shows a common pattern of compasses, which are used for drawing circles and arcs. One leg terminates in a needle point and the other leg can be fitted with pencil or pen. An additional needle-pointed leg can also be obtained for converting the instrument into another pair of dividers for emergency use. For large circles and arcs a lengthening bar, Fig. 9, is valuable.

Both legs of the compasses are jointed so that they can be bent to keep the point more or less perpendicular to the paper.

Needle points are removable and are usually shouldered at one end—this end is best for use in drawing circles, as the point does not penetrate the paper too far. The instrument should be held at the top—see illustration of dividers in Fig. 7, and pressure must be only sufficient to keep the centre from slipping and to maintain a smooth, even line for the curve. The two points of the compasses must be carefully adjusted. The pencil lead should be the same grade as the ordinary pencil being used on the same drawing. A half-inch length can be cut from the bottom of the pencil for the purpose. It should be sharpened to a fine chisel point and arranged tangential to the circumference, although for small circles a round point is probably better.

Pens are capable of adjustment in the manner of ruling pens described later. The thickness of the ink line should be tested at the side of the paper before the required curve is drawn. To avoid blots thick lines should be built up rather than drawn by opening the pen widely.





SPRING BOWS Fig. 11

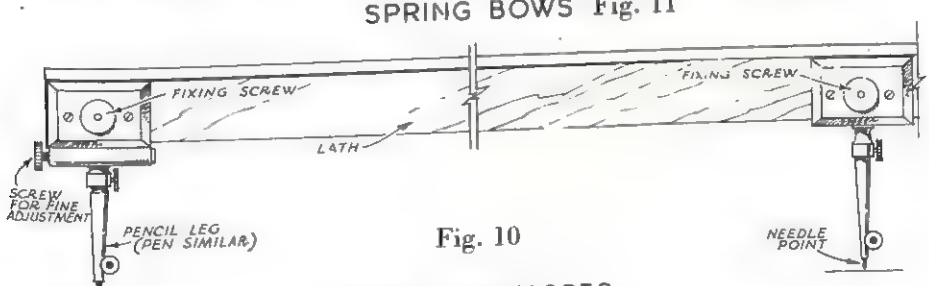


Fig. 10

BEAM COMPASSES

DRAWING INSTRUMENTS

Beam Compasses

For drawing larger circles than are possible with ordinary compasses and the lengthening bar, beam compasses, as illustrated in Fig. 10 can be used. They consist of a centre point and a fitting, with interchangeable pencil and pen legs, which are screwed to a wooden lath to give the radius required, fine adjustments being made by means of a special screw attachment. Any suitable lath can be used; those specially made are up to 60″ in length.

The Roller Beam Compasses is an alternative type serving the same purpose.

Spring Bows

Small dividers and pencil and pen compasses for accurate and fine work are called spring bows and are illustrated in Fig. 11. Adjustment is made by means of a screw either at the side, as shown, or in the middle of the instrument.

Ruling Pens

Fig. 12 shows one type of ruling pen. The instrument is used with T-square or set-square for drawing straight ink lines. A good ruling pen is one of a draughtsman's most useful assets. Pens should be carefully tested on purchase. The blades should be of even length, each one smoothly rounded at the end. Those bought in sets are often unsatisfactory. One blade should be hinged or pivoted for cleaning purposes. Ink should never be allowed to dry in the pen and the blades should be frequently wiped on a piece of fine, firm rag. Woolly materials and blotting paper are not suitable.

Pens are filled by means of the quill in the cork of the ink bottle, Fig. 19, or by dipping an ordinary pen in the ink and transferring it to the blades. The ruling pen itself should not, of course, be dipped in the ink bottle. It is better not to put too much ink between the blades at one time.

The thickness of line is obtained by means of the adjustment screw. The line should be tested at the side of the paper or on a piece of similar paper whenever adjustment has been made.

In use, the pen should be held vertically against the edge of the T-square or set-square and drawn smoothly along the paper. If the pen is pressed hard against the ruling edge, or if the pen is inclined so that the point goes under the edge, the ink will probably run and cause smudges. Most people have some difficulty at first in using a ruling pen, but practice rapidly leads to success.

Thick lines in ink should be built up in two or three rulings, care being taken with junctions and corners.

Many draughtsmen now prefer a drawing pen which is based on the fountain pen principle and can be used for considerable periods without re-filling. Interchangeable nibs are used for various thicknesses of ruled lines—the consistency of which is another advantage—for lettering, and for freehand lines.[1]

Scales

Scales are thin narrow strips of ivory or boxwood (with or without celluloid edges), 12″ or 6″ long (12″ is convenient in use, but 6″ can be carried in the pocket) with the edges divided into various units. Fig. 13 shows the appearance of one side of a 6″ scale which is "Armstrong" divided, i.e. having $\frac{1}{8}$″, $\frac{1}{4}$″, $\frac{1}{2}$″, and 1″ scales on one side and $\frac{3}{8}$″, $\frac{3}{4}$″, $1\frac{1}{2}$″, and 3″ scales on the other. The end unit of each scale is subdivided into twelve parts, so that it is an easy matter to work in feet and inches with any of the scales used for architectural drawings, see p. 75. The scale shown is also "open-divided", that is, with the subdivisions marked at the ends only, and is easier to read than the closed type where feet and inches are concerned.

Scales are best if oval on section for architectural drawings so that the edges can be brought close to the surface of the paper for marking off or measuring distances. For surveying drawings the flat section is better Scales should never be used for ruling lines or for any other purpose for which they are not intended; the edges are soon chipped and broken.

See Chapter IV for descriptions of the scales used for various kinds of drawings.

Protractors

A protractor, Fig. 14, is used for measuring or for setting out angles. It is a semi-circular piece of metal or celluloid with the arc divided into degrees, reading both to left and right, and with the centre and diameter indicated. The illustration shows how measurements are made. The protractor is placed so that the centre coincides with the apex of the angle and the diameter lies along one line, the position of the other line on the scale giving the reading.

The most convenient sizes have diameters from 4″ to 6″. The celluloid protractor is to be preferred, but, for architectural drawings, the instrument is superseded by the adjustable set-square. They are, however, used in the plotting of surveys.

[1] Pelican "Graphos" pen.

French Curves

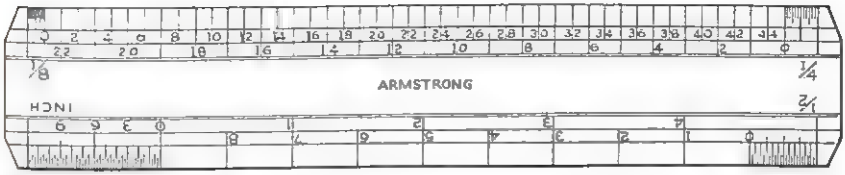
Fig. 15 illustrates a typical french curve. Made of wood or celluloid like set-squares, these are used for the drawing of irregular curved lines, which cannot be made up of arcs. Many shapes are made, but one is usually sufficient for most draughtsmen other than those concerned with railway or ship drawing, etc., and for whom special curves are made. French curves are certainly not an essential item of equipment and, with practice, lines can be drawn freehand more rapidly and with better effect. It is, in any case, a mistake to rely on french curves and so to fail to cultivate freehand drawing.

Pencils

Ordinary drawing pencils are made of cedarwood with "leads" of compressed clay and graphite, and are about 7" long. The hexagonal section is more easily held in the fingers and the pencil does not roll off the board or table. The value of a pencil is, generally, proportionate to its cost. The best should always be used for drawing. It is false economy to buy cheap pencils, the leads of which are gritty or crumbly and make good draughtsmanship impossible.

Leads are made in varying degrees of hardness and softness, ranging from 9H, the hardest, to 6B, the softest. The extreme grades are very little used. Most drawing can be carried out perfectly well in HB or F. Setting out lines and fine work may be done in H; rough sketching in B. Beginners, particularly, should not use pencils harder than H. It is a common error to resort to a hard pencil because the point lasts longer and the line is less likely to smudge. But, properly used, an HB pencil will keep its point just as long and will give a much better line whilst permitting greater freedom of wrist action. Hard pencils bite into the paper and make harsh wiry lines. Smudging is due to carelessness and the student should learn to avoid rubbing the lines of his drawing. This matter has to be stressed, but no real progress in drawing can be made while hard pencils are used. References will be made later to the use of other and special pencils.

When a pencil has been reduced to about half its original length by sharpening, the "balance" tends to be destroyed and it becomes difficult to control in the fingers. The short length should then be put in a holder, of which there are many types, and so can be used down to the last half-inch. Drawing with a short stub of pencil should not be attempted. In an emergency, a strip of paper can be rolled around the end and gummed, to increase the length and make the pencil more manageable.



SCALE

Fig. 13

OVAL SECTION OF SCALE

PLAN OF PENCIL

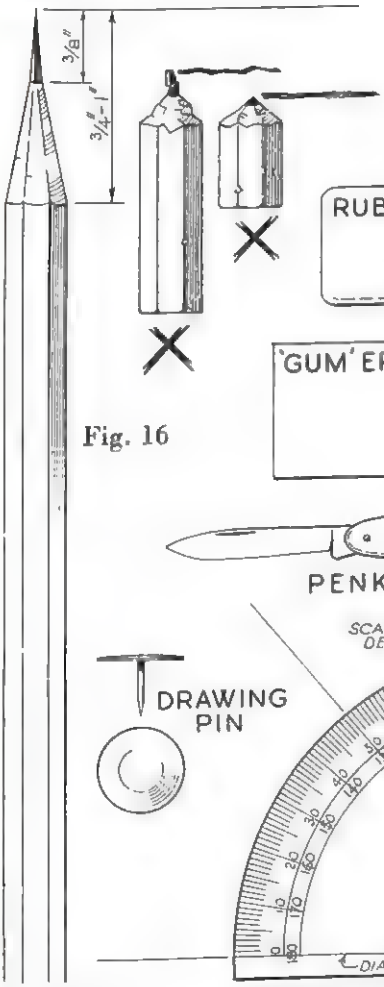


Fig. 16

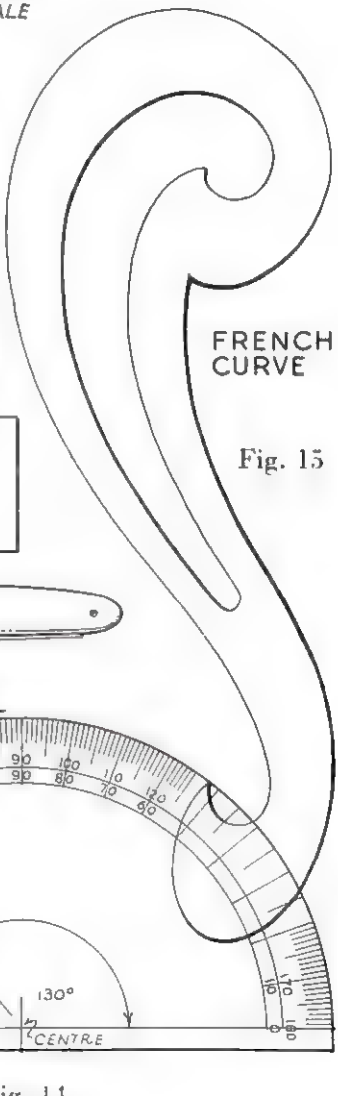
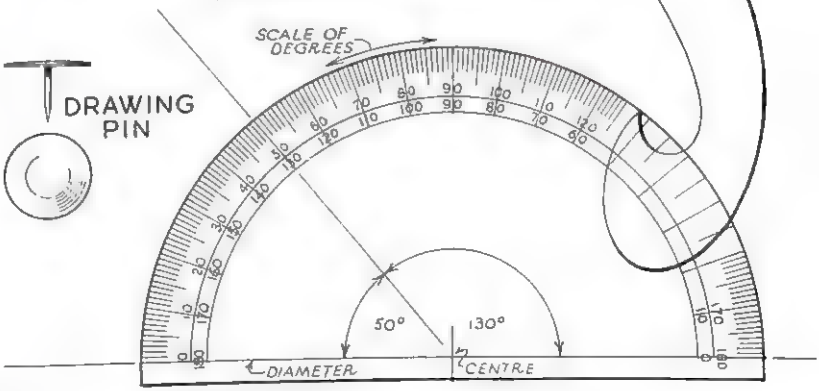


Fig. 15



PROTRACTOR

Fig. 11

Pencil points should be long, round, and evenly tapering, as shown in Fig. 16. The exposed lead should be about $\frac{3}{8}''$ long, and the wood cut back a further $\frac{3}{8}''$–$\frac{5}{8}''$. The point must be round, and then, if the pencil is slowly revolved as lines are drawn, it will wear away evenly and remain sharp for some time. So-called chisel points are useless except for compasses. Satisfactory lines cannot be drawn with blunt or jagged points.

The best way of sharpening a pencil is by means of an ordinary penknife. The pencil is held in the left hand, below table-level and pointing downwards so that chips and lead dust fall to the floor and not on the drawing paper, and with the penknife in the right hand inclined cuts are made firmly and regularly to remove the wood around the point. The final sharpening is done with the penknife blade held more or less at right-angles to the lead—this reduces the risk of a sudden cut going right through the point. The fingers should be wiped or blown clean afterwards as a certain amount of dust usually adheres to them and would otherwise get transferred to the paper. Pencils should not be sharpened with the lead held against a thumb—a sure way to make hands and clothes dirty—nor should safety-razor blades be used—they are much too sharp and difficult to control. Sandpaper pads, which unfortunately are sold for sharpening pencil points, are an abomination and should never be used. Not only are they invariably too coarse to produce anything like a good point, but they make an intolerable amount of dust which is rapidly transferred to fingers, clothes, and drawing paper.

Mechanical pencil sharpeners which can be either screwed to the table or wall are generally efficient and save a certain amount of labour, although the points usually need a final touch of the penknife.

It must be realised that pencils require frequent sharpening when in continuous use, and the beginner should start with a good stock and not be surprised if they wear out quickly.

Erasers

Alterations, corrections, and the removal of unwanted pencil lines are best made by rubbing with a soft white rubber. Erasers should be large enough to be easily gripped, but very large rubbers last too long and as the outside surface becomes hard and useless in time, it is probably better to keep to those about 1″ square. When the surface of the rubber is affected it can be cut away or, if not too bad, rubbed clean on an odd scrap of paper—a procedure which is always necessary if the eraser has not been used for some time.

When a large area of paper has to be cleansed the so-called gum eraser is probably quicker and more gentle to the surface.

For removing soft pencil shading, charcoal and pastel, which are smeared by an ordinary eraser, a special plastic or putty rubber must be used.

Ink lines are removed by hard erasers of shape shown in Fig. 17. As usually only a small portion of an ink drawing has to be removed and the surrounding lines disturbed as little as possible, the rubbing is best done through a thin metal or celluloid rubbing shield, Fig. 18, which has openings to suit areas to be erased.

Electrically operated erasers are sometimes installed in large drawing offices. The machine is suspended over the drawing table and is drawn down to the surface of the paper and a small motor rotates rapidly a piece of pencil rubber or ink eraser.

The small particles of rubber which result from rubbing out should be carefully removed from the surface of the paper by blowing or by lightly flicking with a clean, smooth duster. Some draughtsmen can effectively remove the particles with sweeps of the palm of the hand. It is important, however the job is done, to remove every single crumb and, if the drawing is in pencil, not to smear the line.

Drawing Ink

Waterproof Indian ink is the black ink used for line drawings. It is best used from a small (1-oz.) bottle, as illustrated in Fig. 19, having a cork with quill for filling ruling pens and other instruments. There are a number of different makes. The processes of manufacturers vary and the products are not equally good. Some inks are sticky and do not run freely, others are uneven in quality and deteriorate rapidly. A little experimenting will soon reveal the most suitable.

The bottle should always be kept corked, except when the pen is being filled, to keep dust out and to lessen the risk of accidental spills. A useful hint in avoiding the latter is to stand the bottle in a circular hole in a block of wood or cardboard lid of a suitable size. Special iron and rubber bottle-holders are sold for the same purpose. In warm weather it may be found that the ink will run more freely if it is slightly diluted with clean, preferably distilled, water. Bottles should not be shaken once they are in use or any sediment which may have collected at the bottom will be disturbed. Inks should never be mixed and dirty pens must not be used—chemical action may be set up and the ink become lumpy.

Drawing inks are also obtainable in about twenty different colours.

Chinese Stick Ink

This is referred to later in Chapter VIII.

Freehand Pens

Every draughtsman requires some good freehand pens. Most manage very well with two, one for very thin lines and the other for medium lines, Fig. 20. Thick lines should always be built up. The ordinary "mapping" pen is suitable for fine work and small lettering, and an ordinary penholder fitted with a sharp and flexible steel nib[1] to suit the draughtsman's hand will usually suffice for other purposes. Most pens have to be worn in with use, and then, when working well, become a valued possession.

Lettering Pens and Stencils

These are described later in Chapter III.

Colours

Water-colours are extensively used for drawings of all types, from the conventional indication of materials on constructional drawings to full colour perspectives. For all purposes the colours are usually taken nowadays from tubes or pans; sticks and cakes are not often seen. Using colours from pans is thought to be more economical, but if left for any length of time the material becomes hard and is difficult to soften again quickly. Tube colours keep softer longer and are more quickly mixed and blended, but a certain amount is wasted every time they are used as it is impossible to calculate exactly how much to squeeze out. Tube colours keep cleaner; pans, especially if in a colour box, often get other colours mixed with them.

Further references are made to the use of water-colours later in this book, and some pigments are named. The beginner should purchase colours as required and so build up a working range gradually instead of starting out with an arbitrary selection, many of which may never be used. At the same time, only experience can reveal the possibilities of each, so a little exploration is to be encouraged.

A colour box is not a necessity and may be a nuisance; the colours can be kept quite well in any small tin box.

"Artists" quality water-colours should always be used for work of any importance. Other qualities are more or less adulterated and good results cannot be obtained.

[1] Gillott's No. 303 is recommended.

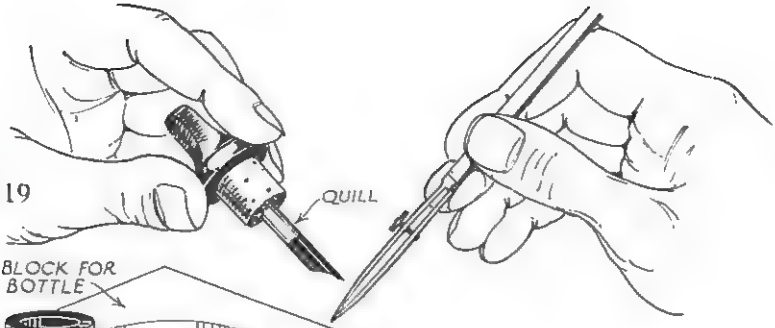
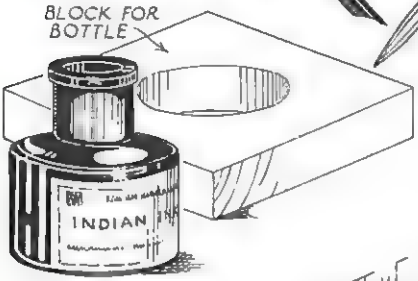


Fig. 19



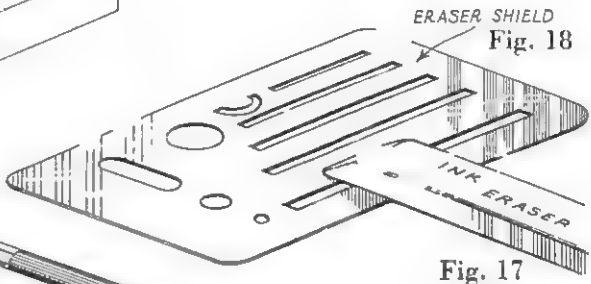


Fig. 18

Fig. 17

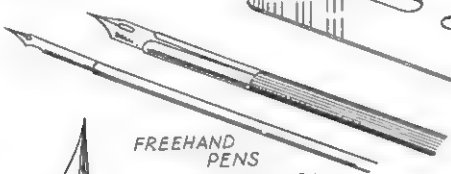


Fig. 20

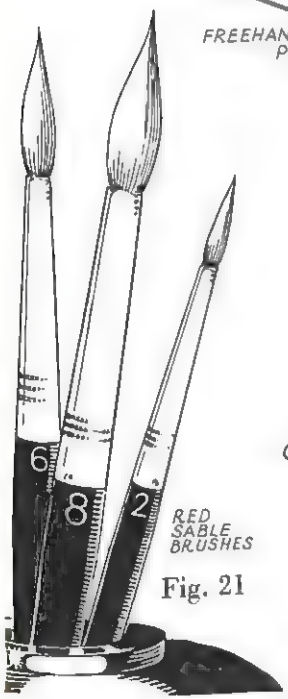


Fig. 21

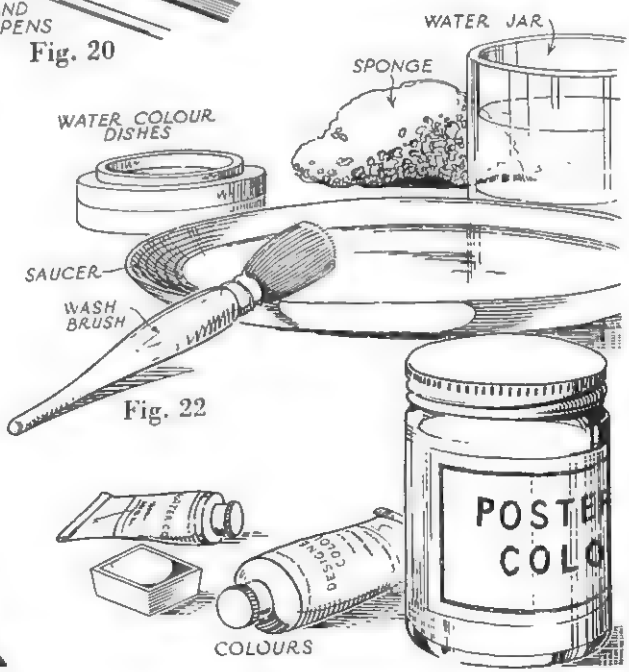


Fig. 22

Poster Colours

These, in small or medium size pots and tubes, also play a large part in the colouring of many types of drawings. For similar purposes, but for better results, Designers' Colours[1] can be substituted. Further references are made later to technique.

Care and common sense will avoid the wasting and spoiling of colours. Caps should be replaced on tubes and jars promptly after use to prevent the contents becoming hard and unusable. Dirty brushes and dirty water should never be allowed to touch fresh colour. When mixing colours the brush must be rinsed clean before a new colour is taken up. The water jar should be large, with a wide mouth, preferably of clear glass, so that it can be seen when the water gets muddy. The water should be changed when it becomes discoloured.

Dishes

Two or three large saucers and about half a dozen good-sized water-colour dishes, as sold in sets or nests, are required for mixing colours and holding washes. They should be glazed and white; coloured and patterned dishes affect the apparent hue of the pigments. Little jars or tins should not be used as heavy colours deposit particles of pigment at the bottom and they are not properly stirred up in the wash. Slopes and slant slabs are not much used as they do not hold a sufficient quantity of liquid for large drawings. Dishes should be thoroughly cleansed after use.

Brushes

Most requirements are met by three red sable brushes, sizes 2, 6, and 7, in metal ferrules and wood handles, Fig. 21, and one camel-hair "wash brush" in a quill, Fig. 22.

Brushes vary in quality and must be carefully selected. A poor brush can be a serious hindrance to success. Sable brushes should come to a fine point and should have plenty of spring in the hairs. The point of a brush can be tested by dipping it in water and drawing the hairs along the palm of the hand, turning it round at the same time. The hairs should come easily to a fine point—if not, the brush should be rejected. The "spring" can be tested by gently pressing the hairs against the hand or other firm surface and feeling how they straighten again when the pressure is released. A brush without spring is of little value. The spring is soon destroyed, incidentally, by rough usage.

[1] Manufactured by Messrs. Winsor and Newton.

Wash brushes hold a good quantity of water, but do not come to a point, and for this reason some draughtsmen prefer a large size red sable, say No. 12.

Brushes must be kept clean. Colour should never be allowed to dry in the hairs. Brushes should be wiped carefully on clean rag after washing and left standing upright in a jar, as illustrated in Fig. 21. They must not be left with the hairs in the water jar. If they have to be carried about they should be tightly held by a rubber band to a stiff strip of card somewhat longer than the longest brush, so that the hairs are protected.

Drawing Pins

Small, flat-headed pins are best for fixing the paper to the board in most cases. Large ones are unsatisfactory as they catch the T-square. They should be well-made of brass with sharp round points. The type with the "point" stamped out of the head is of little use.

As the heads should hold the paper, the pins must be pressed well into the board. Four pins, one at each corner, should be sufficient if put in about $\frac{1}{2}''$ from the edge of the sheet. Whenever a drawing is re-pinned the previous pin-holes, unless enlarged or torn, should be used again. Pins can usually be taken out easily by finger and thumb-nail, but the blade of an old pen-knife can be inserted under the head to prise it up in the case of a stubborn one.

Drawing Papers

There are two main classifications of drawing papers: (1) machine-made papers, such as cartridge, which are used for exercises and comparatively unimportant drawings, and (2) hand-made linen papers, such as Whatman's, used for important drawings. Mention is made of other types of papers, where necessary, in later chapters.

Cartridge

This is sold in sheets on the usual standard drawing paper sizes of:

Antiquarian	$53'' \times 31''$
Double Elephant	$40'' \times 27''$
Atlas	$34'' \times 26''$
Imperial	$30'' \times 22''$
Royal	$24'' \times 19''$
Half Imperial	$22'' \times 15''$
Quarter Imperial	$15'' \times 11''$

Fig. 23 shows these sizes drawn to a comparative scale. Imperial, Double Elephant, and Antiquarian are the ones most

commonly used. The paper is made in three thicknesses: "Thin", "Medium", and "Stout". The "Thin" is usually too flimsy to be of much value. It is also obtainable in rolls of widths 30″, 40″, and 60″ by 25 yds. in length, either unmounted or mounted on cotton or holland. The rolls can be conveniently cut into the various standard sheets or used for extra large drawings, and are probably more economical for the busy office.

Unmounted cartridge paper has right and wrong sides which can be distinguished by examination—the wrong side has a slightly but regularly pitted surface, and the cut edge of the sheet is usually turned down towards the wrong side.

The surface is fairly satisfactory for pencil drawing and the "Stout" quality will take ink moderately well, but it is not really suitable for colour washes except those of a most limited nature.

Whatman's Paper

This is also obtainable in sheets of the standard sizes, and in three surfaces: "Hot Pressed" (smooth), "Not" (medium), and "Rough". The first-named is the one used most extensively and is satisfactory for pencil and ink drawing, and for various methods of colouring and rendering. It has to be "stretched" for wash work, as later described in Chapter VIII. The other two surfaces are used chiefly for colour work, particularly for broad treatments.

Whatman's is available in sheets mounted on cotton or holland up to 60″ × 60″ and mounted on boards up to imperial size.

Sizes of Drawings

The advantages of standardised sizes for drawings are that they enable a more economical use of drawing and tracing paper, sensitised paper and cloth for prints, etc., to be made, and that the binding together and storing of the drawings becomes easier.

Fig. 25 illustrates sizes recommended by the Australian Institution of Engineers, based on 30″ and 40″ roll widths and a uniform relationship between the length and breadth of each sheet, so that larger sheets can be cut or folded exactly without waste into the smaller sizes, and photographic enlargement or reduction of a sheet brings it into one of the larger or smaller sizes.

Fig. 26 shows standard sizes recommended by the British Standards Institution. The sheets can be economically obtained from 30″ and 40″ roll widths and while the large number of arbitrarily selected sizes used in the past have been reduced, certain traditional drawing paper and commercial stationery sizes still in common use are included. The same figure also shows recommended positions for punched holes for binding in folder form.

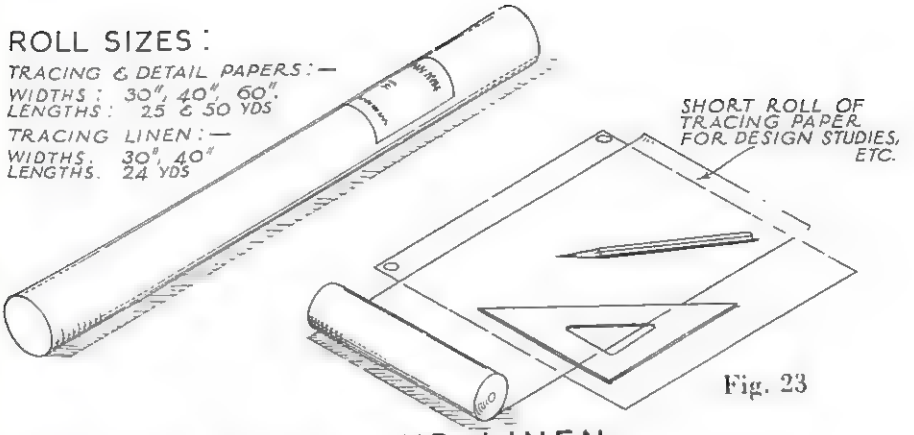
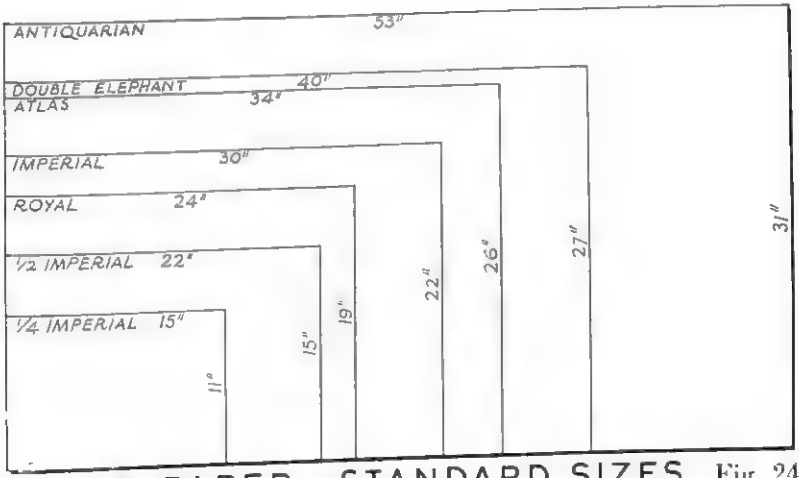
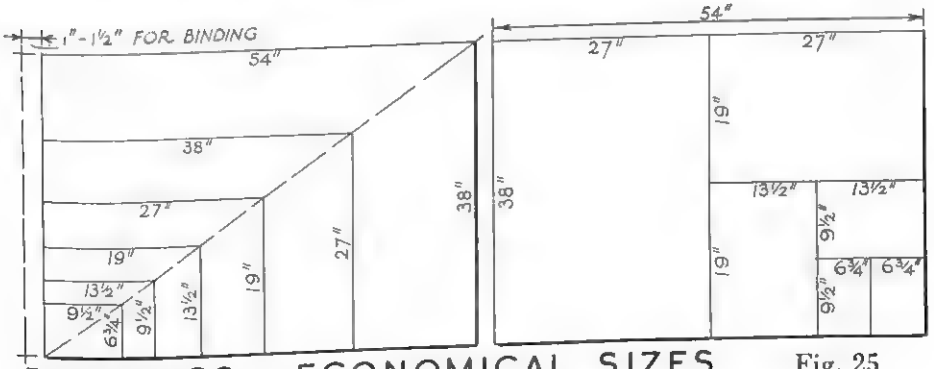


Fig. 23

TRACING PAPER AND LINEN



DRAWING PAPER - STANDARD SIZES Fig. 24



DRAWINGS - ECONOMICAL SIZES Fig. 25

Fig. 27 shows a method, also a B.S.I. recommendation, for folding prints for dispatch or for filing to foolscap letter sizes. The drawings can be folded and unfolded without removal from the file. The ordinary commercial stationery punch is suitable for this type of filing.

The folding of drawings is not, of course, to be recommended for general use. Drawings should preferably be kept flat. If rolled for carrying, the roll should be as loose as possible. Drawings and prints to be used in Quantity Surveyors' offices should always be dispatched rolled, not folded.

Tracing Paper and Cloth

These materials are specially treated paper and linen to make semi-transparent sheets which when placed over original drawings enable the lines underneath to be clearly seen and copied or traced. The tracings thus made can then be used as negatives, again by virtue of the transparency, for the making of any number of further copies by the photo-printing process as described in Chapter VI.

Tracing Paper can be obtained in sheets in standard drawing paper sizes, but it is more usual and economical to buy it in rolls. These rolls, with a few exceptions, are either 25 yds. or 50 yds. in length by 30″, 40″, or 60″ in width. For roughing out designs and many other purposes, it is convenient to have a handier, shorter roll, Fig. 23. Rolls 12″ in width are sometimes available, but, if not, it is well worth while cutting a 10″ length off a 40″ roll or cutting a 30″ roll into three equal lengths (the cutting can be done with a small-toothed saw).

There are three thicknesses of tracing paper: thin, medium, and stout, and two surfaces: smooth and matt. Different makes vary so much, however, that it is difficult to generalise as to the most suitable kinds. A number should be tried out. Thin papers are usually good enough for sketching on, but are too flimsy for important work, especially in ink. The smooth surfaces are better for pencil drawing as the rougher kinds wear down the point too quickly and tend to smudge and smear. Further remarks on technique are made in Chapter VI.

Tracing cloth or linen is nearly always made in rolls, although short lengths can be purchased at so much the inch. Rolls are usually 24 yds. long by 30″ or 40″ wide. The material is generally tinted blue, but white can also be obtained. It is far more expensive than tracing paper and is only used for important "master" tracings and records, although to a lesser extent now than formerly. The method of using it is described later.

Sheets of tracing paper and tracing linen can be made specially with lithographed border lines, titles, etc., for office use.

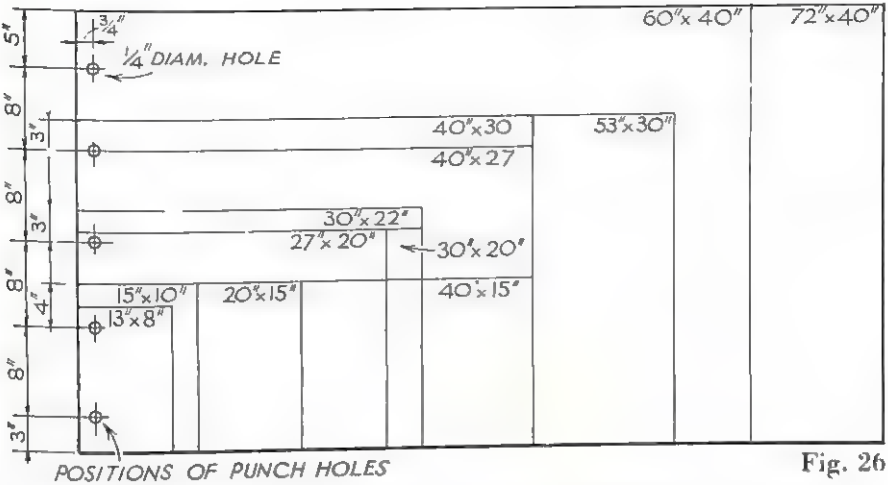
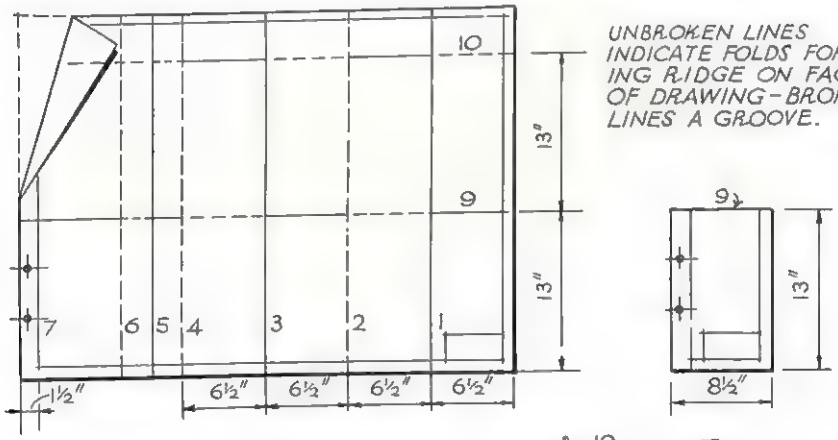
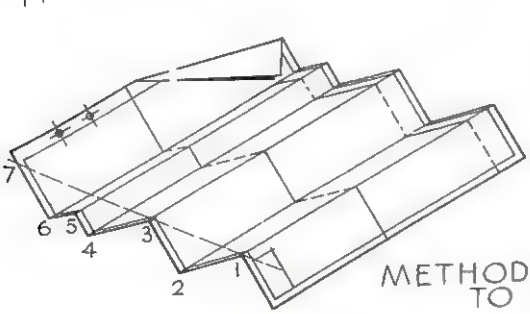


Fig. 26

DRAWINGS - B.S.I. RECOMMENDED SIZES





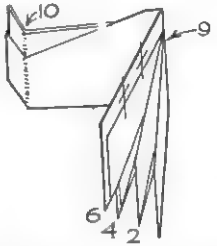


Fig. 27

METHOD OF FOLDING PRINTS TO FOOLSCAP SIZE

FILING OF PRINTS - B.S.I. RECOMMENDATION

Detail Paper

This is like a thick tracing paper and is used chiefly for full-size detail drawings and sometimes for preliminary sketch designs. It is transparent enough for the copying of large-scale, strongly drawn details, yet white enough to show up the work clearly. It is not normally used for photo-printing purposes. Rolls are 50 yds. long by 30″, 40″, and 60″ wide. There are a number of varieties.

Drawing Tables, etc.

It is beyond the scope of this book to deal in detail with drawing-office equipment; reference can be made to catalogues for particulars of the various kinds of drawing tables, drawing machines, stools, chests, etc., which are available.

In general, however, a drawing table should be firm and steady, and about 3′ 0″ in height. There should be ample room on the top not only for the drawing board, but also for instruments, jars, etc. Working in cramped conditions can be a big handicap.

The table should be arranged so that the light, natural and artificial, should come from the front and left of the draughtsman. A drawing office without any sunlight can be a dreary place, but direct sunlight on or near the drawing board should be avoided.

CHAPTER II

LINE DRAWING

Pencil Drawing

LINE drawing in pencil should be mastered first; it is the best introduction to drawing in any medium.

Almost everyone has "drawn" with a pencil from an early age, but little benefit is usually derived from this kind of intermittent and undirected practice. Only bad habits seem to be formed. It is wise, therefore, on setting out to make a serious study of draughtsmanship, to forget any previous ideas of drawing, and to start as if pencil and paper had never been handled before.

In the previous chapter something was said about the materials required and the use of various instruments. Preliminary exercises in pencil drawing can be carried out with the aid of drawing board, T-square and set-squares, H and HB pencils, and good quality cartridge paper.

The first step is to learn how to draw straight lines. Straight lines in pencil should be *firm*, *clean*, and of *even strength*. Start by pinning down the paper, right side up, squarely on the board. Sharpen an HB pencil, as previously described. Give the T-square a wipe with a duster and place it on the board with the head against the left-hand edge—if you are left-handed you can get a special T-square which can be held against the right-hand edge of the board, but most left-handed draughtsmen seem to manage quite well in the ordinary way. Holding the T-square steady in a position towards the top of the sheet, draw with the pencil along the ruling edge from left to right, pressing the point on the paper sufficiently to make a clear line, but not so hard as to make a groove. Turn the pencil slowly round in the fingers as you move it along. The completed line should be exactly the same thickness and strength throughout its length. Make sure that the pencil keeps the same angle with the T-square from start to finish or the line will be wavy.

Now move the T-square down the paper an inch or so and repeat the operation. If necessary, try to improve on the first line. Draw a number of parallel lines in this way until you are satisfied with the quality of the lines. If you find the line becoming "woolly", Fig. 28, it is probably because the pencil needs sharpening; if the line is uneven and broken, it may be that your arm or wrist movement is jerky and the pressure

erratic; to correct this is merely a matter of muscular control, which comes with practice.

Having drawn a few good horizontal lines, pass on to the use of set-squares and the drawing of vertical and inclined lines. Take the 45-degree set-square or the closed adjustable set-square and with this practise drawing lines, as shown in Fig. 28 (2). One edge of the set-square rests on the blade of the T-square and is held in position where required by the left-hand, which also holds the T-square firm. Lines are drawn with the pencil along the other edges of the set-square in the directions indicated by the arrows. A number of parallel lines should be drawn bearing in mind the precautions mentioned above.

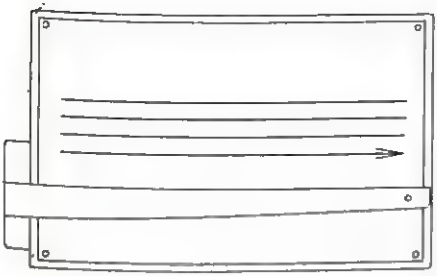
The 60-degree set-square or the adjustable set-square set to this angle can be used similarly, as shown in Fig. 28 (3), for vertical lines and lines at 60 degrees and 30 degrees to the horizontal.

By a combination of 45-degree and 60-degree set-squares it is possible to draw lines at 15 degrees and 75 degrees to the horizontal, as shown in Fig. 28 (4). This is worth trying a few times for practice, as there are three things to manipulate with the left hand, but it is seldom necessary to use this method, and the advantages of the adjustable set-square which can be set to these and any angle in such cases is obvious.

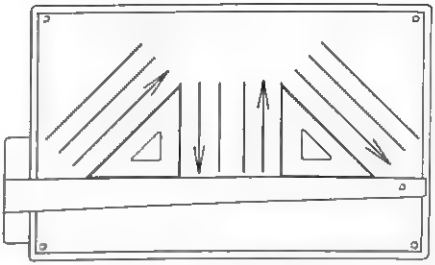
When a number of lines are to be drawn parallel to an inclined line, as may occur in the setting-out of roof-tiling, etc., the method shown in Fig. 28 (5) can be used. Place a set-square along the inclined line so that another of its edges is at right-angles to the line. Then gently bring up the T-square until it is against this edge of the set-square, hold it tightly, and then, by moving the set-square along the T-square to the required positions, lines parallel to the first one can be drawn. This method should be practised with lines at varying angles.

Remember in all cases to keep the pencil well sharpened and held properly against the ruling edge.

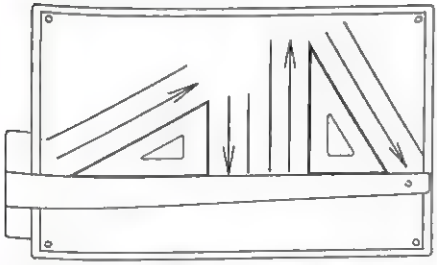
The second step in learning to use the pencil is to combine lines so as to construct figures and shapes, e.g. squares, rectangles, etc. Fig. 29 (1, 2 and 3) show the setting-up of a rectangle. Two parallel horizontal lines are first drawn any suitable distance apart, say, 2 or 3 inches. The lines should be faint though clear and regular. Their exact length is not important. On the lower line two points, *A* and *B*, are marked (in the example the distance between *A* and *B* is made the same as the distance between the lines, so the resulting figure is a square). Using the set-square, two vertical lines are now drawn through *A* and *B* to cross the first two lines. These also are faint lines and are termed *construction lines*, and to bring out



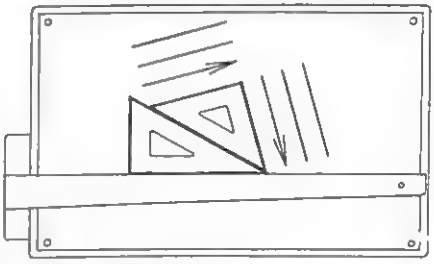
1. HORIZONTAL



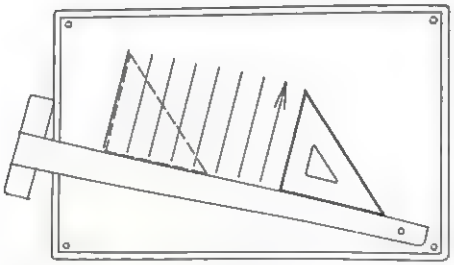
2. VERTICAL AND 45°



3. VERTICAL, 30° AND 60°



4. 15° AND 75°



5. PARALLEL *TO ANY GIVEN LINE*

LINES SHOULD BE FIRM, CLEAN, AND OF EVEN QUALITY

NOT COARSE AND 'WOOLLY'

NOR DOUBLE AND BROKEN

STRAIGHT LINES

Fig. 28

the required figure they have to be strengthened where necessary. This is shown in Fig. 29 (3) by a thickening of those parts of the lines which actually define the rectangle, but in a pencil drawing the lines need not necessarily be made thicker as long as they are made stronger, i.e. "blacker", by going over the faint lines and putting more pressure on the pencil. Care must be taken that the "lining in", as it is sometimes called, is done exactly over the construction lines and that irregular or double lines do not result.

Note that the final lines cross slightly where they meet at the corners of the rectangle. This is done to give added definition to the shape and to give a sharper, cleaner appearance to the drawing. It is a widely adopted custom in architectural draughtsmanship, but is not generally used for finished town-planning, surveying, and engineering drawing because of possible confusion, and junctions are accurately made in works of these kinds. In architectural drawings, however, it seldom happens that an exact meeting of lines is necessary, and it is therefore a waste of time, apart from the tendency for such corners to look "rounded". Nevertheless, the lines must certainly not fall short, although the crossing should not be irregular or exaggerated.

Fig. 29 (4) shows the crossing of lines at a junction to a larger size, and also a bad example where the lines fail to meet.

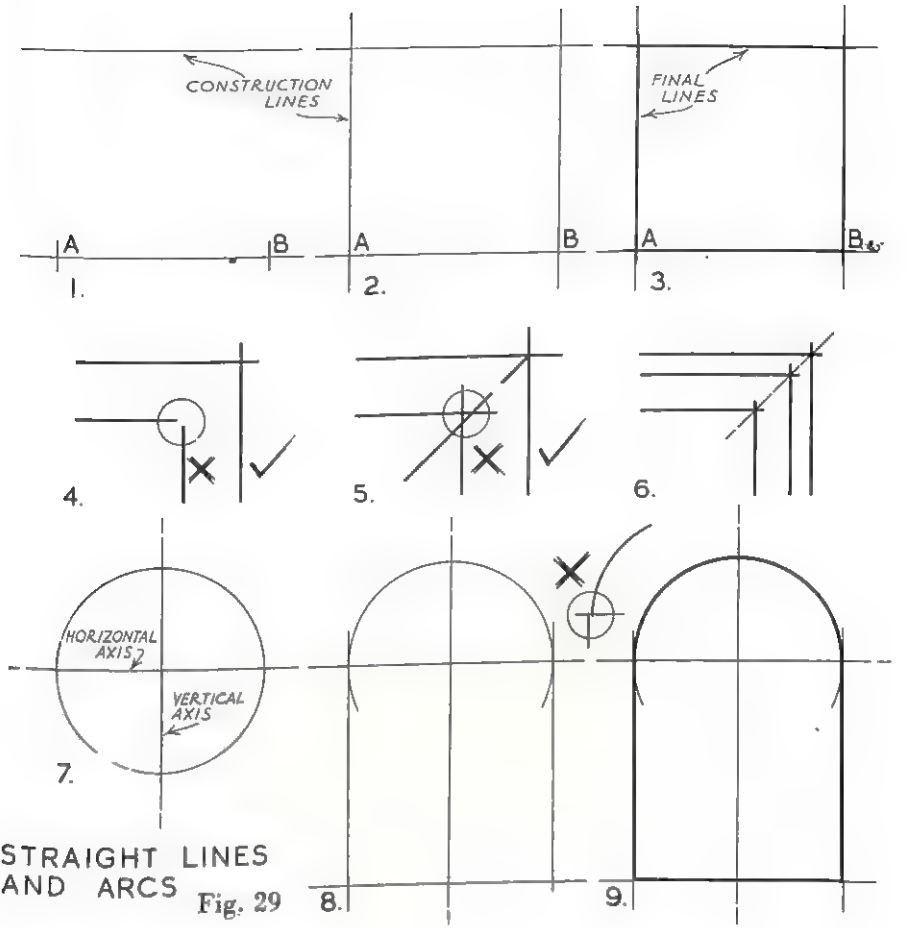
Fig. 29 (5) shows the making of a junction of three lines. It is inadvisable in finished drawings to make them all cross. It is generally better to let the two outer ones cross and to bring in the third accurately to the meeting point.

Fig. 29 (6) shows the right-angle junctions of several pairs of lines. When the first pair of lines have been drawn it is helpful to draw a faint line at 45 degrees through the junction and so provide a guide to the meeting points of the others. This also saves setting out the spacing of the lines in both directions.

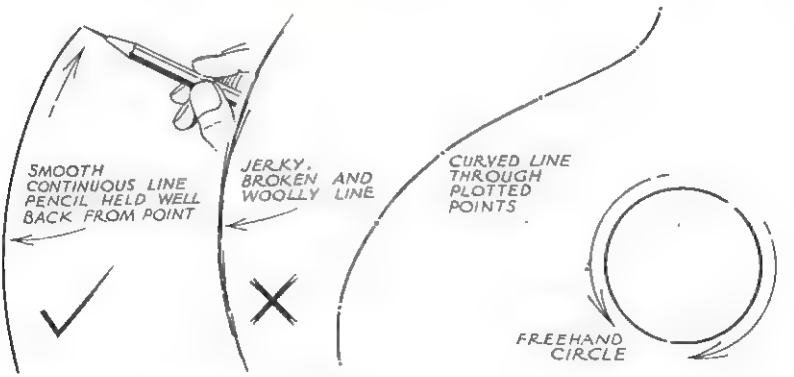
In addition to being made to cross at junctions, the lines can be made a little stronger at these points by putting more pressure on the pencil. Such a slight emphasis to the ends of final lines can quickly become an unconscious habit with practice, and the effect is greatly to increase the legibility and attractiveness of the drawings.

In drawing circles and arcs the positions of the centres should be established first and the principal axes, i.e. horizontal and vertical lines passing through the centres, should be lightly drawn. Along one of these lines the length of the radius in each case can be marked and the curve drawn with compasses, Fig. 28 (7).

If arcs are to be joined to straight lines, it is always better to draw the curves first. In the case of an example such as



STRAIGHT LINES AND ARCS Fig. 29



FREEHAND CURVES Fig. 30

Fig. 29 (8 and 9), the axes should be drawn lightly first, then the arc with compasses also lightly, and then the vertical lines from the points where the arc cuts the horizontal axis. The strengthening of the lines should be done in the same order, i.e. the arc, or semi-circle as it is, first, and then the vertical lines.

When the above elementary steps in draughtsmanship have been mastered, a sound basis has been laid for the making of any drawing in line. A word might be said here on freehand drawing, although this is dealt with further in a later chapter, as a certain amount comes into almost every drawing. The main principle is to get the same quality and strength in the freehand lines as in those drawn with instruments. The tendency to be guarded against is the coarsening of the freehand lines. It is a matter of practice, but keep the pencil well sharpened and try to draw smooth, *continuous* freehand lines with even pressure. Avoid "sketchy" lines made with jerky movements. Hold the pencil well back from the point for long, flowing curves. Sometimes, when the curve is long and sinuous, it is easier to draw if a number of points along its length are first lightly plotted. Small freehand circles can be best drawn as two curves, as indicated by the arrows in Fig. 30.

Keeping the Drawing Clean

It is important to keep drawings as clean as possible and to preserve the surface of the paper, especially if colour is to be used. To these ends the following points should be constantly kept in mind:

1. Use clean equipment and instruments and good pencils.
2. Keep hands clean and touch the paper with the fingers as little as possible.
3. Avoid unnecessary rubbing of the surface of the paper with T-squares and set-squares. Move them by lifting rather than by sliding. A piece of paper folded two or three times to make a narrow strip about 1″ wide and pinned along the left-hand side of the board is helpful in lifting the T-square blade just clear of the paper and so reducing friction.
4. Sharpen pencils away from the drawing board and table.
5. Make any erasures carefully and remove all rubber crumbs by blowing or lightly flicking with clean handkerchief or hand.
6. If much drawing is to be done on several small areas of the sheet, cover the whole of it with tracing or detail paper in which suitable flap "windows" through which to work can be cut.

Inking-in

If a drawing is to be finished in ink, it is always better to draw it first completely in pencil, taking just as much care as if it were to be so finished. The inking then becomes a straightforward process without innumerable breaks for the working-out

of details and the correcting of mistakes, and time is thereby probably saved in the long run. There is no excuse for making a careless, dirty pencil drawing on the grounds that it is subsequently to be inked-in.

The methods of using the ruling-pen and other instruments have already been described. The sequence in inking-in should generally be as follows:

1. Centre lines.
2. Circles and arcs—drawn with ink compasses.
3. Horizontal lines.
4. Vertical and inclined lines.
5. Hatching and blacking-in of sectional parts, etc.
6. Dimensions lines.
7. Freehand lines, arrows and arrow-heads, dimension figures, notes.
8. Titles, etc.

To avoid being held up while some lines are drying, it may not be possible to keep strictly to this sequence, but systematic working reduces the chances of errors and omissions. As with pencil drawing, main outlines should be strengthened for increased definition and meeting lines should slightly cross in the case of architectural drawings.

If erasures are necessary, an ink rubber (p. 15) can be used *gently* until the lines or blots are removed. For small areas or short lines a sharp razor-blade held vertically to the surface of the paper and moved quickly backwards and forwards will do the job. The surface must not be roughened or subsequent ink lines will run and become ragged, although this tendency can be overcome to some extent by smoothing the affected area by pressure from a bone knife-handle, etc.

When the inking has been completed and checked, a soft pencil rubber should be used over the sheet to remove any dirt and pencil lines.

Geometrical Drawing

Having acquired the elementary technique of line drawing, the next requirement is practice and yet more practice. Geometrical drawing is an excellent way of obtaining this practice and at the same time a knowledge of various constructions and figures continually used in the making of technical drawings. Brief mention is made here of some of the more important examples, but for detailed explanation of terms, etc., reference should be made to the author's *Descriptive Geometry*.[1]

[1] *Descriptive Geometry for Architects and Builders*, by Leslie A. Lee and R. Fraser Reekie. Edward Arnold and Co., London.

Division of Lines

Fig. 31 shows a number of ways of dividing straight lines into equal parts.

(1) By trial and error, using dividers. This is a fairly quick way and with practice the required distances can be estimated very closely the first time. Spring-bow dividers are used for very short lines to be divided with great accuracy. If the line is comparatively long and the divisions numerous, it is sometimes easier to do the dividing in two stages, e.g. if twenty divisions are required, the line might first be divided into four equal parts and each of these parts into five. Be careful to avoid pressing the divider points into the paper: mark off the required divisions with a touch of the pencil.

(2) Shows a graphical method of dividing a line into any number of equal parts. From one end of the line to be divided, *AB* in the example, another light line is drawn at an acute angle and along it are plotted equal units of any convenient length. From the end of the last of these units, marked 5, a light line is then drawn to *B*, and parallel lines are drawn from the intermediate points, thus dividing *AB* into a similar number of equal parts. This principle is a useful one to remember, and can often be employed using a scale or rule, as shown in (5), to divide into any number of equal parts the distance between two parallel lines. It is, for example, a speedy way of setting out the steps of a staircase, Fig. 102.

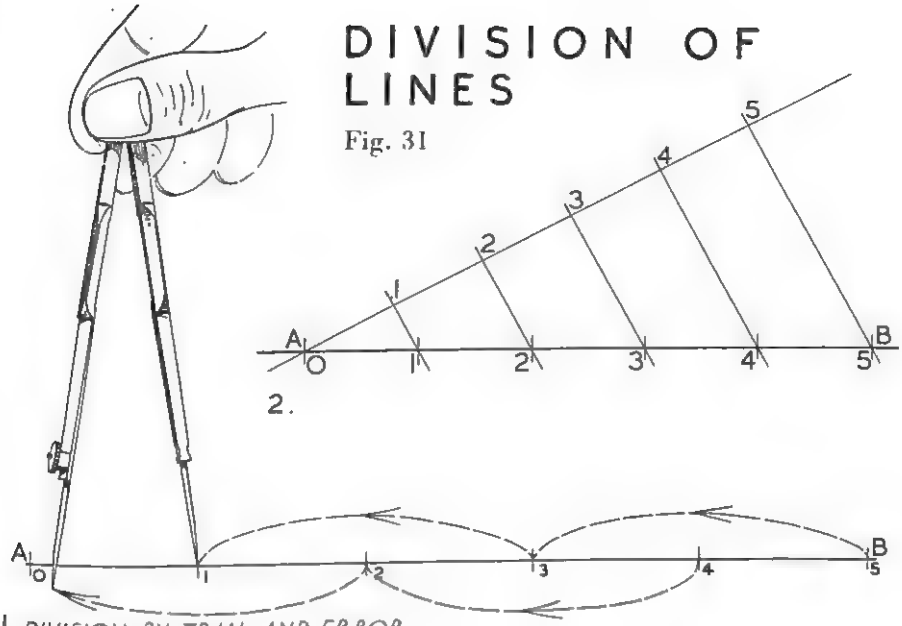
To bisect a line, that is, to divide it into two equal parts, one method is to use compasses, as shown in (3), but for horizontal or vertical lines it is quicker to use a set-square, as shown in (4). By the former method the ends of the line *A* and *B* are taken as centres for the two similar arcs of any radius greater than half *AB*; a line drawn through the intersections of the arcs on either side of *AB* cuts *AB* exactly in the middle. Using a set-square, preferably 45 degrees, lines at the same angle are drawn from the ends of line *AB* to intersect. A perpendicular from the intersection to the line bisects it. From this further similar constructions can be made to divide the line into 4, 8, 16 parts, and so on, although it is unsuitable for more than eight. This latter method is useful for the finding of centre-lines, etc.

Plane Geometry

It is assumed in the following descriptions of the setting up and drawing of common examples of plane figures that it is understood how the lines are drawn using T-square, set-squares, etc.

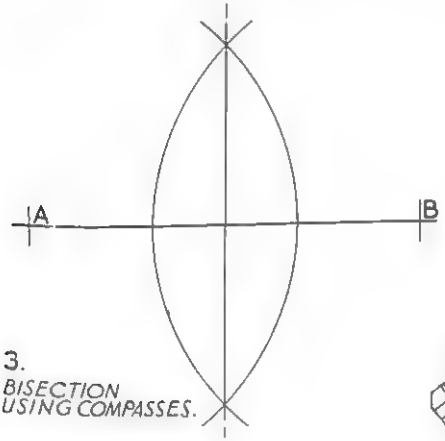
DIVISION OF LINES

Fig. 31

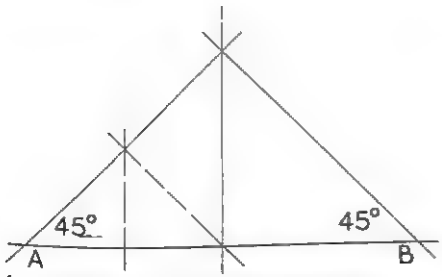


1. DIVISION BY TRIAL AND ERROR USING DIVIDERS

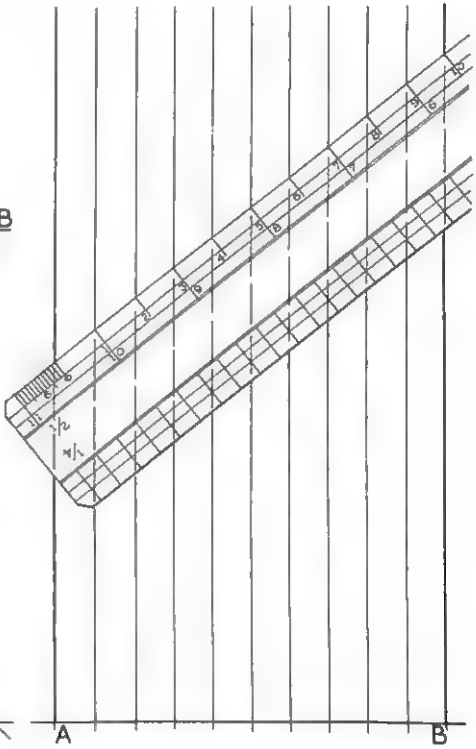
2.



3. BISECTION USING COMPASSES.



4. BISECTION AND DIVISION INTO EVEN NUMBERS OF UNITS USING SET-SQUARE



5. DIVISION USING SCALE

Squares

The simplest way to draw a square, the sides of which are horizontal and vertical on the sheet, is shown in Fig. 32 (1). A horizontal line is drawn and the given or known length of one side of the square is marked on it, in the example marked *AB*; from *A* a light line is drawn at 45 degrees to cut a perpendicular from *B*; from *A* another perpendicular is drawn and to it a horizontal line is drawn from the intersection of the 45-degree line and the perpendicular from *B*, i.e. *C*. *ABCD* is the required square.

Alternatively, Fig. 32 (3), the square could be drawn with the aid of compasses or dividers. Having drawn side *AB* and erected a perpendicular from *A*, with centre *A* and radius *AB* an arc is drawn to cut the perpendicular at *D*. A horizontal line through *D* and a perpendicular from *B* complete the figure. There is, of course, no need to draw a complete arc from *B* to *D*, it is sufficient if the arc merely cuts the perpendicular from *A*. Similarly, *AD* could be set off by dividers or, in some case, marked off from a scale, although this often leads to inaccuracy.

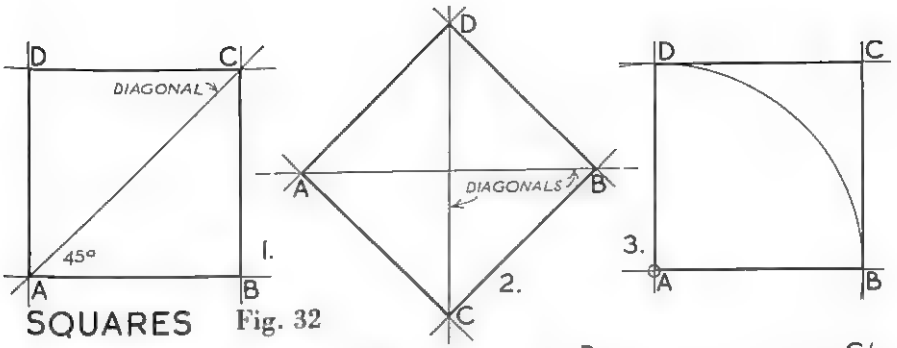
Fig. 32 (2) shows a square with sides at 45 degrees to the horizontal and vertical. This could be drawn by first drawing side *AC*, then a horizontal from *A* and a 45-degree line from *C* to cut it at *B*, and then 45-degree lines from *A* and *B* to meet at *D*. A line joining *C* and *D* is vertical and, incidentally, the intersection of the two diagonals is the centre of the square.

Rectangles

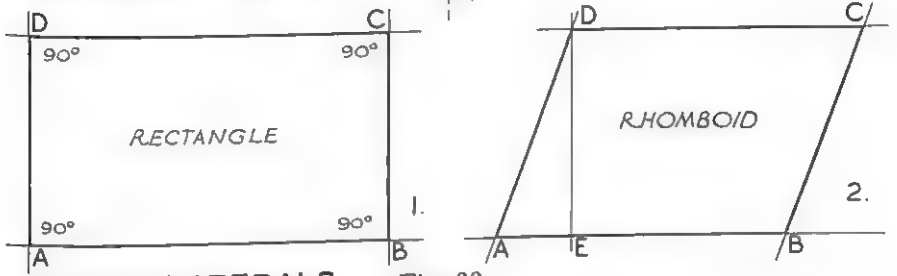
A rectangle is a four-sided figure with equal opposite sides and its angles all right-angles. Assuming the lengths of its sides are known, one side is first drawn, *AB*, in Fig. 33 (1), and perpendiculars are erected from *A* and *B*. Along one of these the length of the adjoining side *AD* is set off, and the figure is completed by drawing a line from *D* parallel to *AB*, cutting the perpendicular from *B* at *C*.

Rhomboid

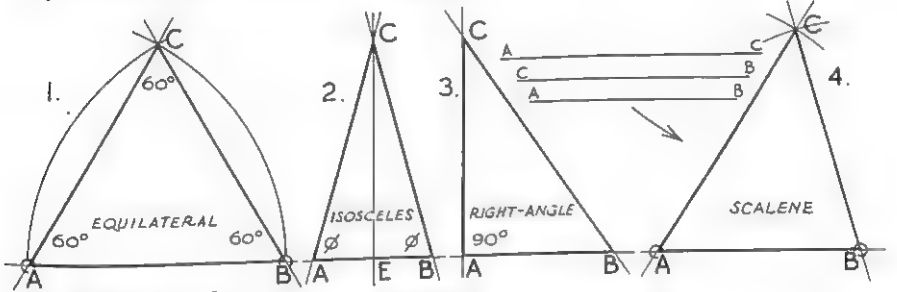
Of other parallelograms, the setting-up of which is similar, the rhomboid is shown in Fig. 33 (2). The rhomboid is a figure having equal opposite sides, but no right-angles. The lengths of the sides and angles must be known before the drawing can be made, but if one angle is known the others can be calculated. One side, say *AB*, is drawn and from *A* at the known angle is set off *AD* equal to the length of the adjoining side. From *D* a line is drawn parallel to *AB*, and from *B* a line parallel to *AD*; the intersection of these lines at *C* gives the required figure,



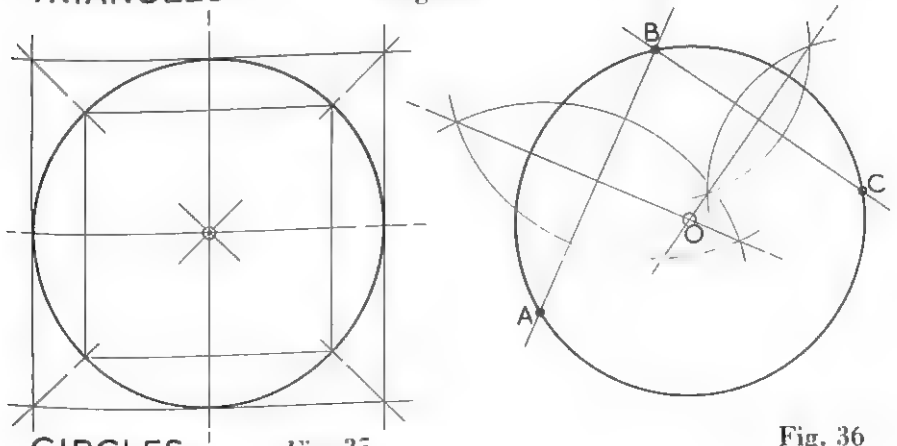
SQUARES Fig. 32



QUADRILATERALS Fig. 33



TRIANGLES Fig. 34



CIRCLES Fig. 35

Fig. 36

ADCB. A perpendicular to *AB* from *D* gives a line *DE* along which the distance between sides *AB* and *DC* can be measured.

Triangles

An equilateral triangle (three equal sides and three equal angles, each 60 degrees), is very simply set up by drawing one side and from each end drawing lines at 60 degrees to intersect, Fig. 34 (1). Alternatively, having drawn one side *AB*, arcs with centres at *A* and *B* and radius equal to *AB* can be drawn to intersect at *C*. Joining *A* and *B* to *C* by straight lines completes the figure.

An isosceles triangle (two equal sides and two equal angles) can be similarly constructed. By drawing first the unequal side and from each end of it drawing lines at the known equal angles to intersect, Fig. 34 (2), or, alternatively, having drawn one side *AB*, with centres *A* and *B* and radius equal to the equal sides drawing arcs to intersect at *C*. Joining *A* and *B* to *C* by straight lines completes the figure.

A right-angled triangle (having two sides at right-angles to each other) can be set up by drawing one side adjacent to the right-angle, erecting a perpendicular of required length at one end and by joining the two free ends. This method applies if the lengths of the two sides at right-angles are known. If only one of these sides and the third side is known, the method is to draw the known side adjacent to the right-angle; at one end of it to erect a perpendicular and then with the other end as centre and with radius equal to the other known side to draw an arc to cut the perpendicular. A line drawn from the intersection to the centre of the arc completes the figure.

To draw a scalene triangle (one having three unequal sides and unequal angles), the lengths of the sides being known, the method—which is applicable to any triangle and is particularly useful when no side is horizontal or vertical on the sheet—is shown in Fig. 34 (4). Any side *AB* is drawn and then with *A* and *B* as centres and with radii equal to the lengths of the other two sides, arcs are drawn to intersect at *C*. Joining *A* and *B* to *C* by straight lines completes the figure.

Circles

Reference has already been made to the drawing of circles and the advisability of establishing centres by lightly drawing the horizontal and vertical axes. Fig. 35 shows how circles can be drawn around and within squares. In the first case, the middle of the square is found by drawing its diagonals; with this point as centre and with radius equal to half the length of

a diagonal a circle can be drawn to pass through the corners of the square. In the second case, the middle of the square is found as before, but the radius is made equal to half the length of one side, that is, the pencil point of the compasses is made to pass through the intersections of the axes and the sides of the square. It is obvious from the foregoing how squares can be drawn within or outside circles.

Fig. 36 shows the plotting of a centre of a circle which is required to pass through the points *A*, *B*, and *C*. *AB* and *BC* are both bisected by the method described in Fig. 31 (3). The point 0, the intersection of the bisectors, is the centre of the circle.

Fig. 37 illustrates various terms descriptive of parts of circles and of lines in relation to circles. Brief definitions, in addition to those previously mentioned, are:

Arc—A part of the circumference.

Chord—A straight line, shorter than the diameter, terminated by the circumference at both ends.

Circumference—A curved line equidistant from a point, the *centre*, confining the circle.

Diameter—A straight line passing through the centre of the circle and terminated at both ends by the circumference.

Normal—A straight line drawn from any point on the circumference in a direction radial to the centre of the circle.

Quadrant—A quarter of a circle in shape and area.

Radius—A straight line drawn from the centre of a circle to the circumference. (Plural—*radii*.)

Radial—A line in the direction of a radius, e.g. the joint lines of a masonry arch.

Sector—A part of a circle contained between two radii which form an angle of less than 180 degrees.

Segment—A part of a circle contained between a chord and its arc.

Semi-circle—A half circle in shape and area; the part on either side of a diameter.

Tangent—A straight line touching the circumference of a circle at one point at right-angles to a normal at that point. In drawing a tangent to an arc, it is better to draw a radius to the tangential point first and then to draw the tangent at right-angles to it, rather than to judge the meeting of the straight line and curve by eye. See Fig. 29.

In Fig. 38 (1, 2, 3, 4, 7 and 8) are examples of combinations of arcs, and of arcs and straight lines. The construction lines are shown and the centres indicated so that the setting-up can be followed and similar exercises practised. The important point to observe is the part played by the construction lines in making easier the accurate joining of the lines.

Fig. 38 (5) shows the junction of a quadrant arc with two lines at right-angles. This is often done by trial and error with unsatisfactory results. The correct method is to draw a light line at 45 degrees from the intersection of the two straight lines

and another parallel to one of them and away from it a distance equal to the radius of the required arc. The meeting of this line with the 45-degree line gives the centre for the curve. If however, the size of the arc is to be judged by eye, the 45-degree line will be helpful in locating the centre of it.

When the arc is to connect two straight lines not at right-angles, as Fig. 38 (6), the method is to draw lines parallel to each of the straight lines at distance away from them equal to the radius of the required arc. The point of intersection is the centre of the arc.

Ellipse

The ellipse comes frequently into architectural drawing, not only as a curve or shape in itself, but also in the representation of circles in various projections, etc. There are several methods of setting up the figure; some locate points on the curve which has to be completed freehand; others give centres from which curves approximating to an ellipse can be drawn. Fig. 39 (1 and 2) are examples of the former; Fig. 39 (3 and 4) of the latter.

(1) The ellipse is constructed in a lightly drawn rectangle, *EFGH*, with sides equal to the major and minor axes, *AB* and *CD*. The half major axis *AO* is divided into a number of equal parts, three in the example (the number depends on the size of the drawing, but as few as possible is advised), and *AE* is also divided equally into a similar number of parts. Lines are then drawn from *C* through the divisions on *AO* to intersect corresponding lines drawn from *D* to the divisions on *AE*. The curve of a quarter of the ellipse has now to be drawn carefully and smoothly through the points of intersection. The rest of the ellipse can be completed by repeating the construction or by plotting or transferred tracing from the curve already drawn.

(2) The trammel method is preferred by most draughtsmen as it avoids the numerous construction lines of the foregoing and other methods. The major and minor axes are first drawn, *AB* and *DC*, intersecting at *O*. A straight strip of card or stout paper (the trammel) is then taken, placed with its edge along the major axis and with a pencil half the length of the axis, e.g. *OB*, is marked on it. The trammel is then placed with its edge along the minor axis so that half the axis, *OD*, can be marked on it within and from one end of the previous marking. By placing the trammel on the drawing so that the two marks separated by the difference between the two axes falls on the axes as shown, then by moving the trammel but always keeping those marks on the axes, the third mark can be made to trace the curve of the ellipse, and a series of light pencil dots gives the plotting.

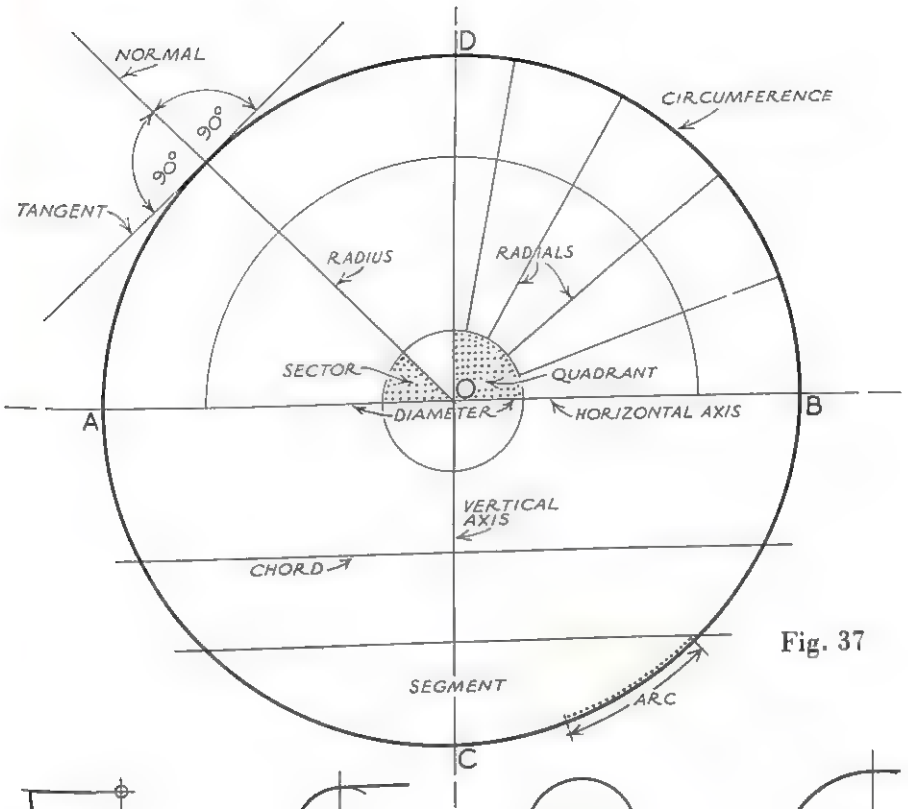


Fig. 37

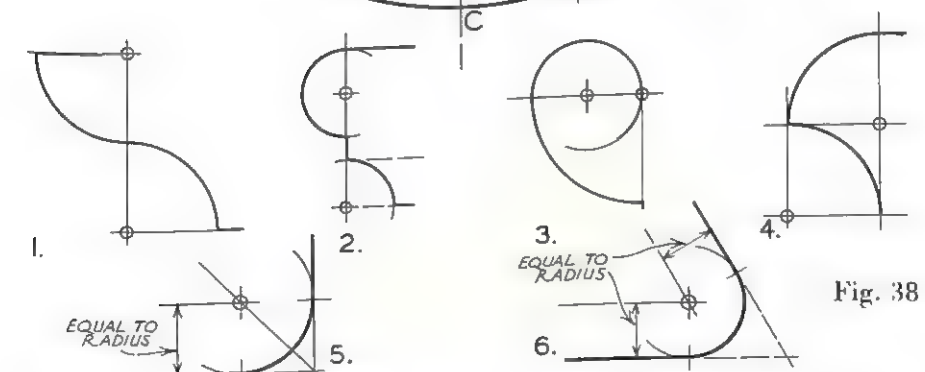
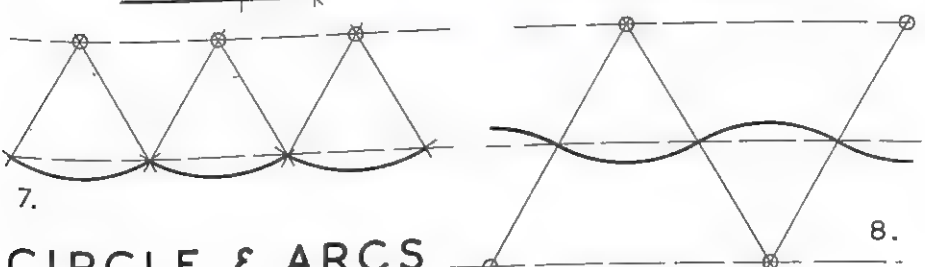


Fig. 38



CIRCLE & ARCS

(3) The construction of half of a pseudo-ellipse formed of arcs struck from three centres is illustrated. *AB* is the major axis and *AD*, greater than half *AB*, is the estimated radius of the first part of the curve, *D* being the centre for the arc, which is continued to cut the minor axis at *E*. *DE* is then bisected and the bisector is continued to cut the line of the minor axis at *O*, which is the centre for the arc *FG* (radius *OE* drawn through *D*). *HB* is equal to *AD*.

(4) The construction of half a pseudo-ellipse formed of arcs struck from five centres. *AB* is the major axis and *OC* is half the minor axis. A rectangle *AFEB* is first set up on *AB*, the sides *AF* and *EB* being equal to *OC*. A line is drawn from *AC* and at right-angles to it a line *FG* is drawn cutting *AB* at *H*. *H* is the centre for the first part of the curve. Then, with centre *O* and radius *OC* an arc is drawn to cut *AB* at *J*. With *JB* as diameter a semi-circle is drawn, from the centre of which a perpendicular is erected to cut the semi-circle at *L*. Along *CG* from *O* a distance *OM* equal to *KL*, the vertical from *EF* to the curve of the semi-circle is marked, and with centre *G* and radius *GM* an arc is drawn to cut arcs struck from centres *A* and *B* with radius equal to *ON*, see drawing. The centres for the curves are *G*, *H*, *P*, *Q* and *R*.

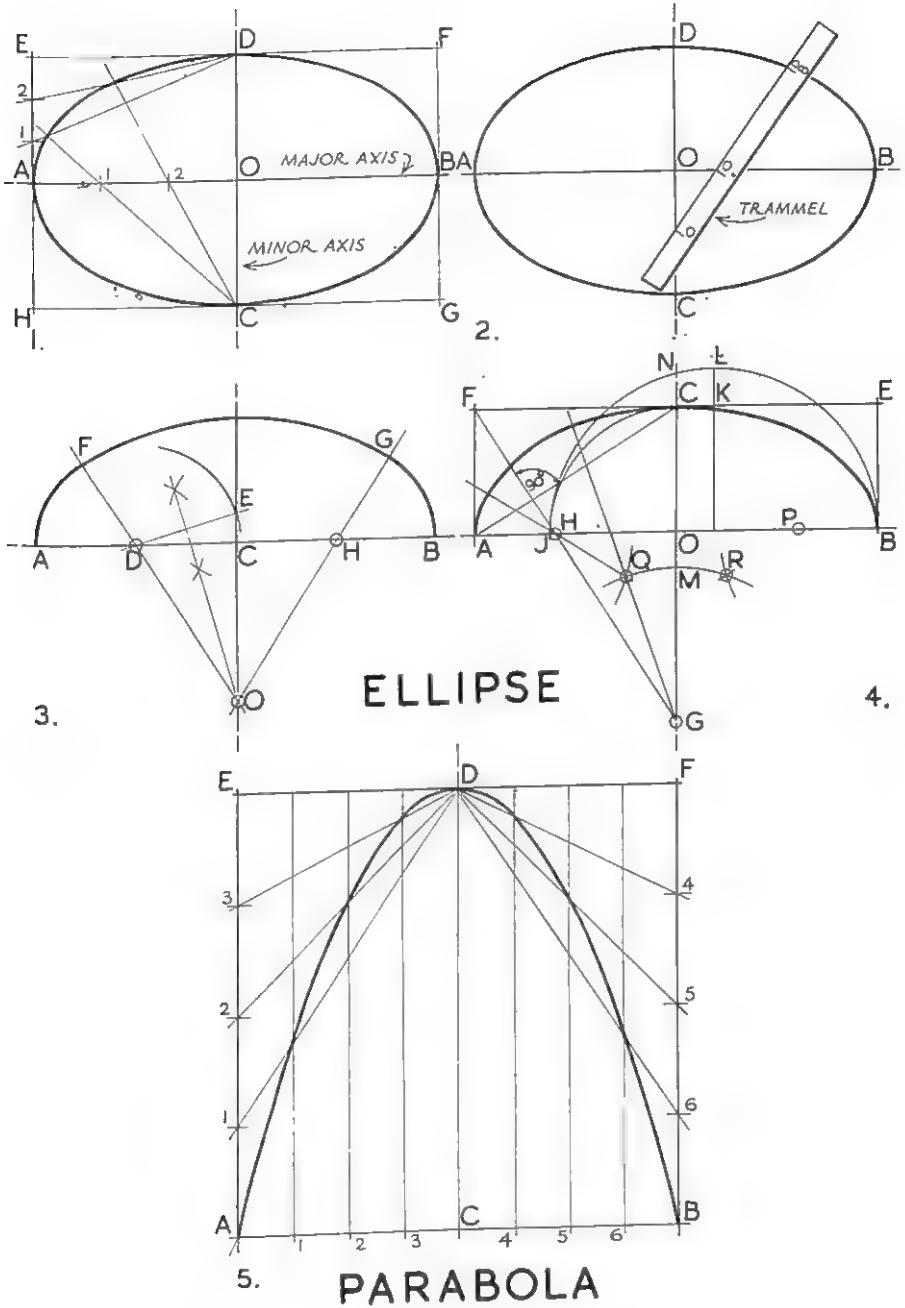
There are other settings out of pseudo-ellipses. They are much used for brick and masonry arches. Careful draughtsmanship is essential, the construction lines being made as light as possible.

Parabola

Parabolic lines and shapes are often required to be drawn, and the simplest setting-up for most general purposes when the required "height" and "width" are known is shown in Fig. 40. *AB* is the "width" or base-line and *CD* the "height" or axis. The rectangle *AEFB* is constructed; *AE* and *FB* are then divided into a number of equal parts, and *AC* and *CB* are similarly divided. Lines are drawn from *D* to the points of division on *AE* and on *FB* to cut corresponding perpendiculars drawn from the points of division on *AC* and *CB*. A smooth curve carefully drawn through the points of intersection is the required parabola.

Regular Polygons

A brief description is given below of the setting-up of the pentagon (five equal sides), the hexagon (six equal sides), and the octagon (eight equal sides), as these are the polygons most commonly required in drawing.


E
D
F
2
1
A
1
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O
MAJOR AXIS
B
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MINOR AXIS
H
C
G
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D
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B
TRAMMEL
C
2.
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A
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A
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B
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PARABOLA

Fig. 40

Pentagon

Fig. 41 (1). If it is required to draw a pentagon within a known circle, the simplest practical method is to divide the circumference of the circle into five equal parts using dividers, and then to join the points with straight lines. This method can, of course, be used for any regular polygon. If the base of the pentagon is to be horizontal, then the divisions should start from the top of the circle, i.e. where the vertical axis cuts the circumference.

If the length of the sides is known, an old but accurate method is shown in Fig. 41 (1) also. One side is drawn horizontally and with centres at each end of it and radius equal to its length arcs are drawn to intersect. Through the intersection a vertical line is drawn. One of the arcs, from the point of intersection to the horizontal line is divided into six equal parts. With the point of intersection as centre and radius equal to the chord of the first division an arc is drawn to cut the vertical line. The point so obtained is the centre of a circle which will contain the required pentagon.

If it is required to draw a pentagon about a given circle, the easiest way is to divide up the circumference into five equal parts, draw radii to the points so obtained, and then tangents to the same points. The tangents form the pentagon, Fig. 41 (4). This method can again be used for any regular polygon. The radii are drawn to facilitate drawing the tangents.

Hexagon

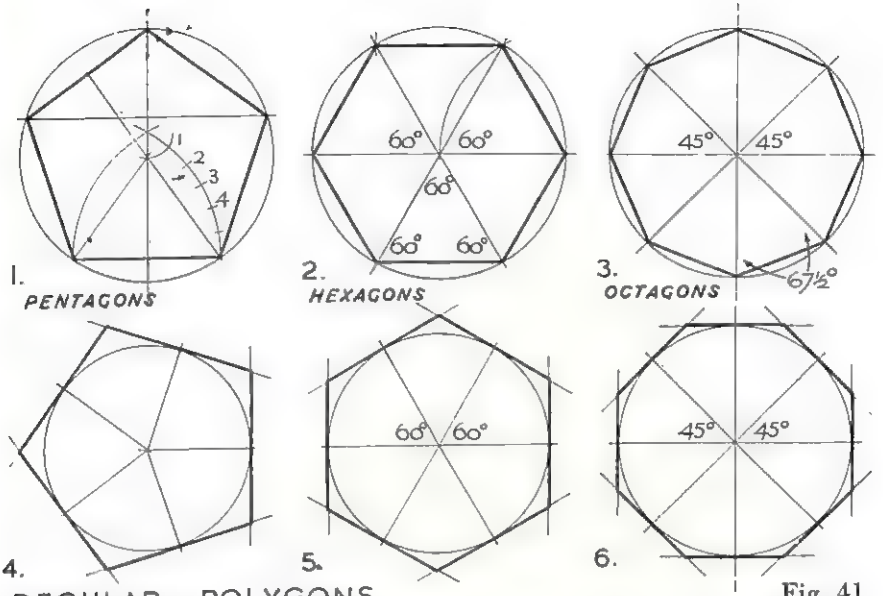
Within a circle a hexagon can be simply drawn by drawing a horizontal and lines in both directions at 60 degrees through the centre to cut the circumference, and then by joining the points so obtained by straight lines, which are also horizontal or at 60 degrees. Or, the radius of the circle can be stepped off around the circumference: it goes exactly six times—Fig. 41 (2).

If the length of each side of the figure is known, its construction using the 60 degree set-square is obvious from the example.

To draw the figure around a circle, again a horizontal and lines at 60 degrees are drawn through the centre to the circumference and tangent lines are drawn through the points of contact, Fig. 41 (5).

Octagon

Within a circle an octagon can be constructed by drawing the horizontal and vertical axes and lines at 45 degrees to the circumference, and then by joining the points so obtained by straight lines, Fig. 41 (3).



REGULAR POLYGONS

Fig. 41

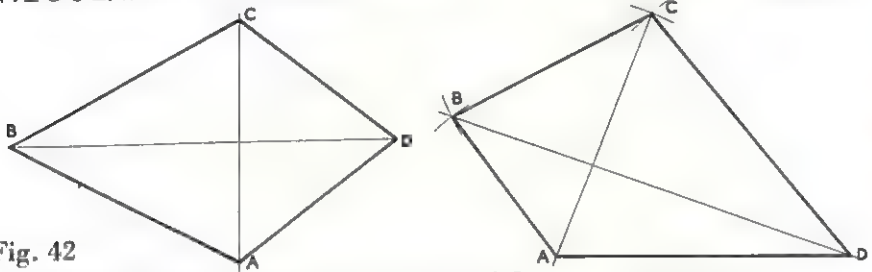
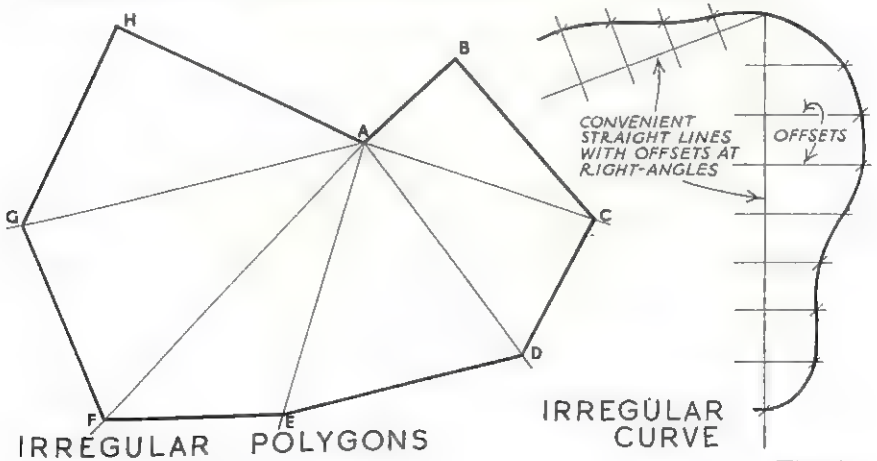


Fig. 42

IRREGULAR QUADRILATERALS



IRREGULAR POLYGONS

Fig. 43

Fig. 44

If the length of each side of the figure is known, it is simplest to draw one side horizontally and then, with an adjustable set-square, to draw lines at $67\frac{1}{2}$ degrees from each end of it to meet at a point which is the centre of the octagon. This enables a circle to be drawn, along the circumference of which can be set out the necessary distances or points for the completion of the figure.

To draw an octagon about a circle, the horizontal and vertical axes and lines at 45 degrees in both directions through the centre are drawn to find tangential points on the circumference. The tangents can then be easily drawn with T-square and 45-degree set-square.

Irregular Quadrilaterals

Two examples of these figures are illustrated in Fig. 42. In the case of the former, the "kite" shape can be set up by drawing the diagonals first and measuring the required distances along them from the point of intersection. In the latter case, which is likely to be a matter of copying or plotting a survey, the lengths of the sides would have to be known and also either the angles between them or the lengths of the diagonals. If the angles are known, then the setting-up can be done with the aid of a protractor or adjustable set-square; the lengths of the lines being measured or transferred from an original by dividers.

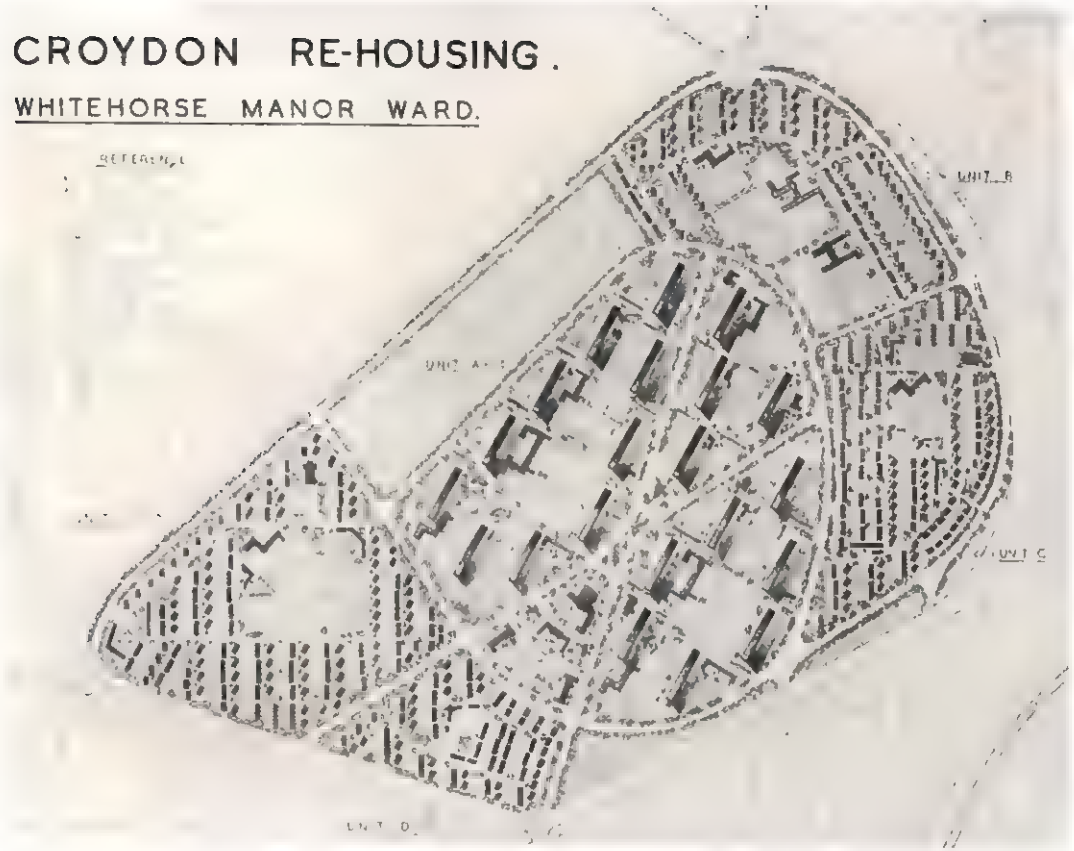
If the lengths of the diagonals are known the setting-out can be made on the basis of triangulation. In the example illustrated, Fig. 42, side AD is drawn first; then, with centre A and radius equal to the length of the diagonal, an arc is drawn to intersect an arc drawn with centre D and radius equal to the length of known side DC. This establishes the position of point C, and by a similar process, using AC as the base-line, the triangle ABC can be drawn.

Irregular Polygons

The drawing of an irregular polygon such as illustrated in Fig. 43 can be made on similar lines to the methods described above for irregular quadrilaterals. If the lengths of the sides and the angles between them are known, as is the case in the plotting of certain types of surveys, the setting-up is made by systematically measuring off lines and angles. If the lengths of the sides and the distances from one corner, point A here, to all other corners are known, the method is to construct the triangles so formed.

Irregular Curves

The drawing of irregular curves, when copied from other


CROYDON RE-HOUSING.
WHITEHORSE MANOR WARD.

drawings, is best done by plotting offsets from convenient straight lines which follow the general direction of the curve. This is illustrated in Fig. 44. The offsets are taken at right-angles to the straight lines. They need not necessarily be spaced at regular intervals, although it is sometimes more convenient to do so.

If the curve is part of a survey, the lines and offsets will have been determined in the measuring and the drawing is therefore a straightforward matter of plotting the data to scale.

Enlargement and Reduction of Drawings

There are various methods of enlarging or reducing a line drawing. Some of the most useful are:

Fig. 45 (1). If, for example, the drawing consists of irregular or complex lines, draw over it a square grid of light lines (or, if the drawing is to be protected, draw the grid on a piece of tracing paper and place over the original), and then for the new drawing make a similar grid but proportionately larger or smaller as required. With this grid as a guide it is comparatively easy to make the copy to the size wanted.

Fig. 45 (2). If a line and its divisions, e.g. a scale, is to be enlarged or reduced in other than a simple mathematical proportion this is a useful method to employ. Line AB with points C and D along it is to be reduced; with centres A and B and radius equal to AB two arcs are drawn to intersect at O, and lines are drawn from O to A, B, C and D. The new length of the line is now measured along OA from O, and a line $A'B'$ is drawn parallel to AB to which it corresponds. Where this line cuts CO and DO points C' and D' corresponding to C and D on the original are found.

Fig. 45 (3). The proportional enlargement or reduction of rectangles is made by drawing a diagonal so that the alteration of the length of one side automatically gives the required length of the adjacent one. Example: $ABCD$ is the rectangle; BD is a diagonal. $EFGD$ is a proportionately reduced rectangle.

Proportional Compasses. These instruments consist of two slotted pieces of metal with points at each end joined by a centre screw, which can be so set that the distance between the long points is equal to that between the short points or is two, three, four or more times that distance up to ten. They can therefore be used for enlarging or reducing simple drawings in such ratios, although they seem to find little favour with present-day draughtsmen.

Pantograph: an instrument for enlarging or reducing drawings in various ratios. By following the lines of the original with one marker, the other traces them to a larger or smaller scale,

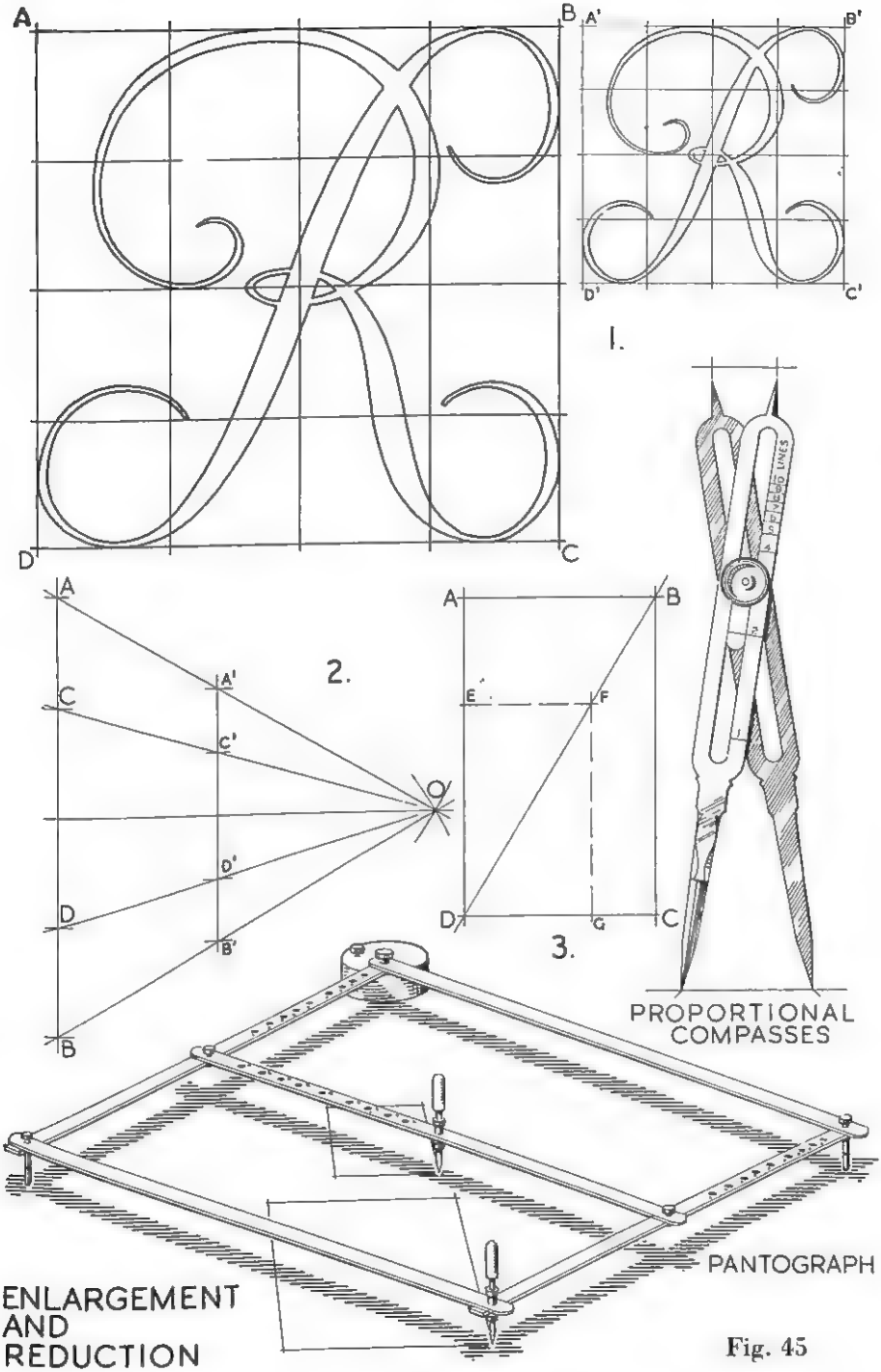

A
B
D
C
A'
B'
D'
C'
1.
2.
3.
E
F
G
O
PROPORTIONAL
COMPASSES
PANTOGRAPH
ENLARGEMENT
AND
REDUCTION

Fig. 45

as the case may be, and in the proportionate ratio to which the instrument has been set. The illustration shows a simple type. The Eidograph is a somewhat similar instrument, but, having only one point of support, is steadier in action. The cost of these instruments is only justified if dealing with a large number of town plans and surveys.

Orthographic Projection

Orthographic projection is the method of showing solid objects which are actually three-dimensional in two-dimensional drawings by means of related views called plans, elevations and sections. Most drawings of buildings are of this nature.

The principle, which although difficult to explain in words, is readily understood when a drawing in orthographic projection is seen, is illustrated by Figs. 46 and 47. Fig. 46 shows a block or rectangle prism, *ABCDEFGH*. Adjacent to it and parallel to its sides are three co-ordinated planes, that is, planes at right-angles to one another. They are horizontal plane, vertical plane 1, and vertical plane 2. If the face of the prism *ABCD* is projected on to vertical plane 1 it appears thereon as a rectangle; similarly, if face *EACG* is projected on to vertical plane 2 it also appears as a rectangle; and likewise with face *EFBA* on to the horizontal plane. Now, if it is imagined that the co-ordinate planes are "hinged", then if the horizontal plane is swung downwards, as it were, through an angle of 90 degrees, and if vertical plane 2 is swung round through an angle of 90 degrees, the three projections will lie in the same plane and the result is as shown in Fig. 47, which is an *orthographic projection* of the prism showing related plan and two elevations.

In actual practice, of course, such a projection is made by drawing first the plan, then the elevation of the front face immediately above and then the end elevation at the side.

The projection, as illustrated, is known as *First Angle Projection*, each view being so placed that it represents the side of the object remote from it in the adjacent view. It is the British Engineering and Continental Standard (excluding Dutch) practice. What is known as *Third Angle Projection* would result in the views being arranged with the plan over elevation 1 and the elevation of face *BFHD*, corresponding to elevation 2, on the left-hand side of elevation 1. Third Angle projection has the advantage of placing the features of adjacent views in juxtaposition, and thus makes it easier than in First Angle projection to project one view from the other when drawing, and also to associate these features when dimensioning or reading a drawing. It is the American and Dutch standard practice.

ORTHOGRAPHIC PROJECTION

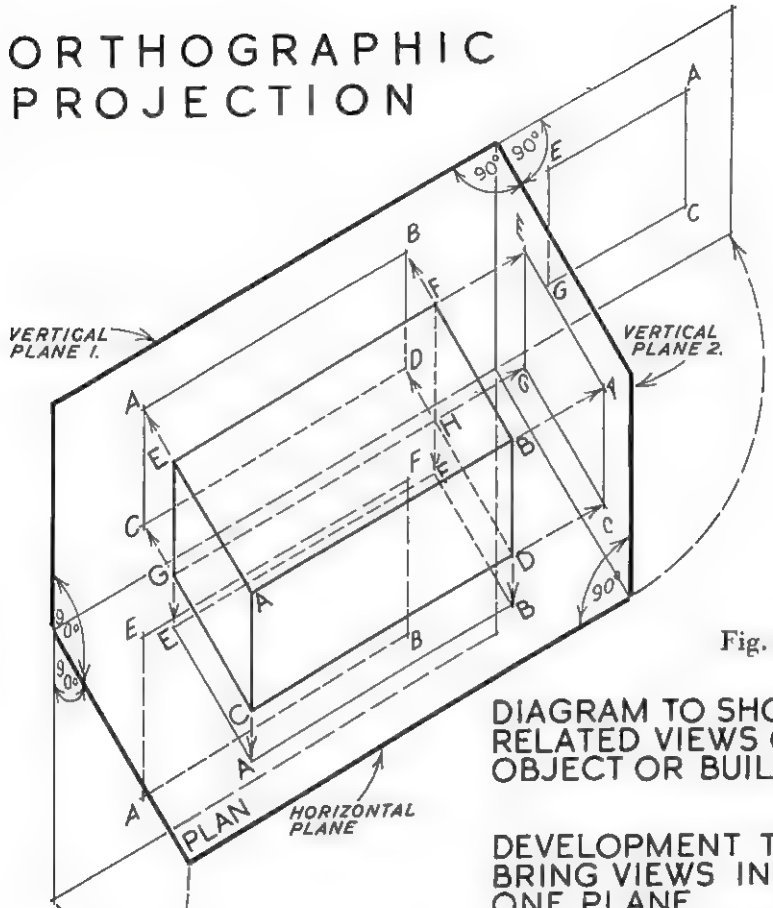


Fig. 46

DIAGRAM TO SHOW RELATED VIEWS OF OBJECT OR BUILDING

DEVELOPMENT TO BRING VIEWS INTO ONE PLANE

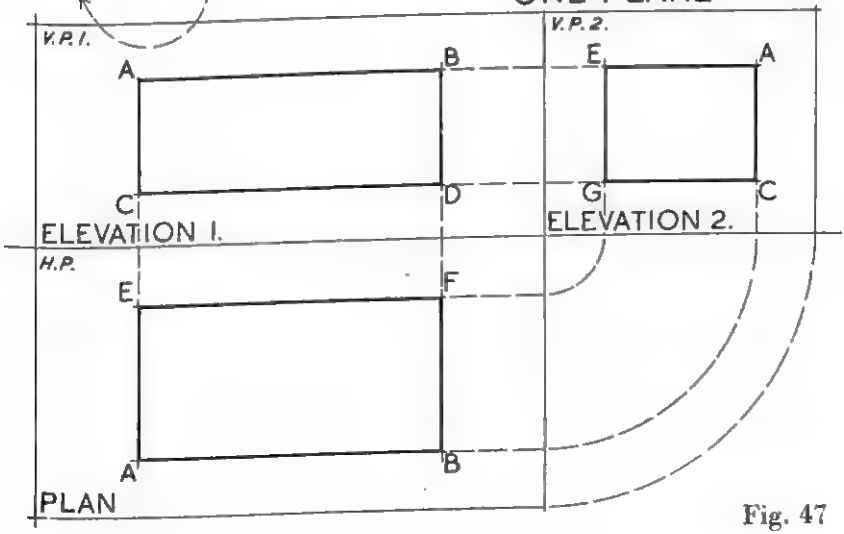


Fig. 47

It is usual, however, for drawings of buildings in orthographic projection to employ a combination of First and Third Angle projections, so that in relation to the front elevation end views are placed as in Third Angle projection and plan views as in First Angle projection.

Although it is sometimes necessary to separate views, so far as possible the above relationship should be observed.

Sections

In addition to plans (horizontal views) and elevations (vertical views), *sections* are also used in orthographic presentation in order to show details of the interiors of buildings and the construction of walls, floors, etc. A section can be described as a view of a building or object seen when it has been cut straight through, usually in a horizontal or vertical direction.

Fig. 48 illustrates various sectional views. Assuming the rectangular prism, referred to above, to be hollow, if cut horizontally the view would be as in diagram 1. This view properly termed a horizontal section is usually called a plan. If cut longitudinally and vertically, diagram 2, the view is termed a *longitudinal or long section.* If cut across and vertically, diagram 3, it is called a *cross section.*

Of course there may be more than one of each type of section necessary and, according to the design of the building or object, several plans, elevations and sections may be required to show it fully. In drawing a building there is usually a plan (sectional plan) through each floor as well as of the roof and the foundations, elevations of all sides, and a number of sections taken at important positions. See later examples, Figs. 106 and 107.

Geometric Solids

Fig. 49 shows various geometric solids represented by orthographic projection in plan, elevation and side elevation. Pictorial views are also shown so that the form in each case will be understood. It is important that the appearance of these solids in two-dimensional views should be fully appreciated as they are the basis of nearly all building forms. Exercises including these and other solids should be practised. Fig. 50 is such an example; the combination of geometric forms are those of the dome, drum and pendentives in building design. It will be seen that the sections are taken diagonally. Projection lines are shown so that the plotting of the curves can be followed.

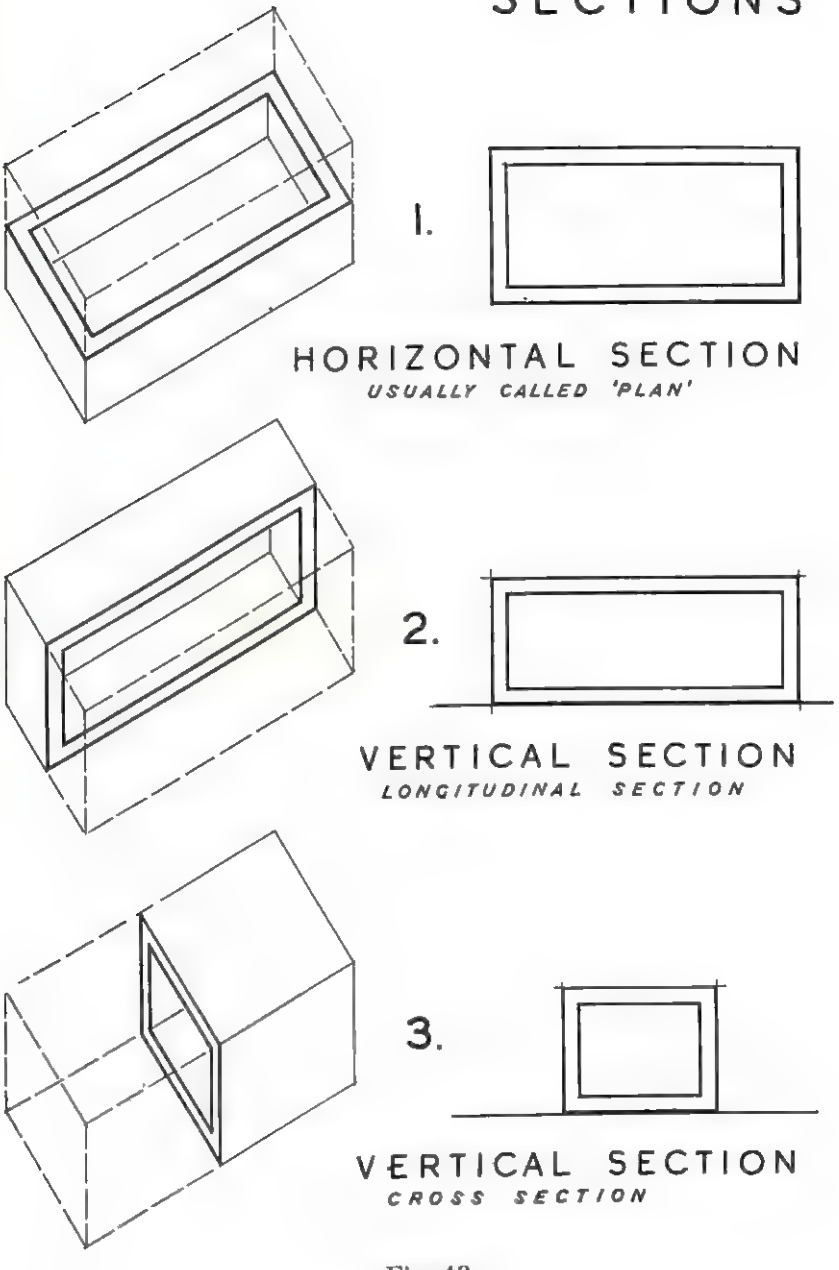

SECTIONS
1.
HORIZONTAL SECTION
USUALLY CALLED 'PLAN'
2.
VERTICAL SECTION
LONGITUDINAL SECTION
3.
VERTICAL SECTION
CROSS SECTION

Fig. 48

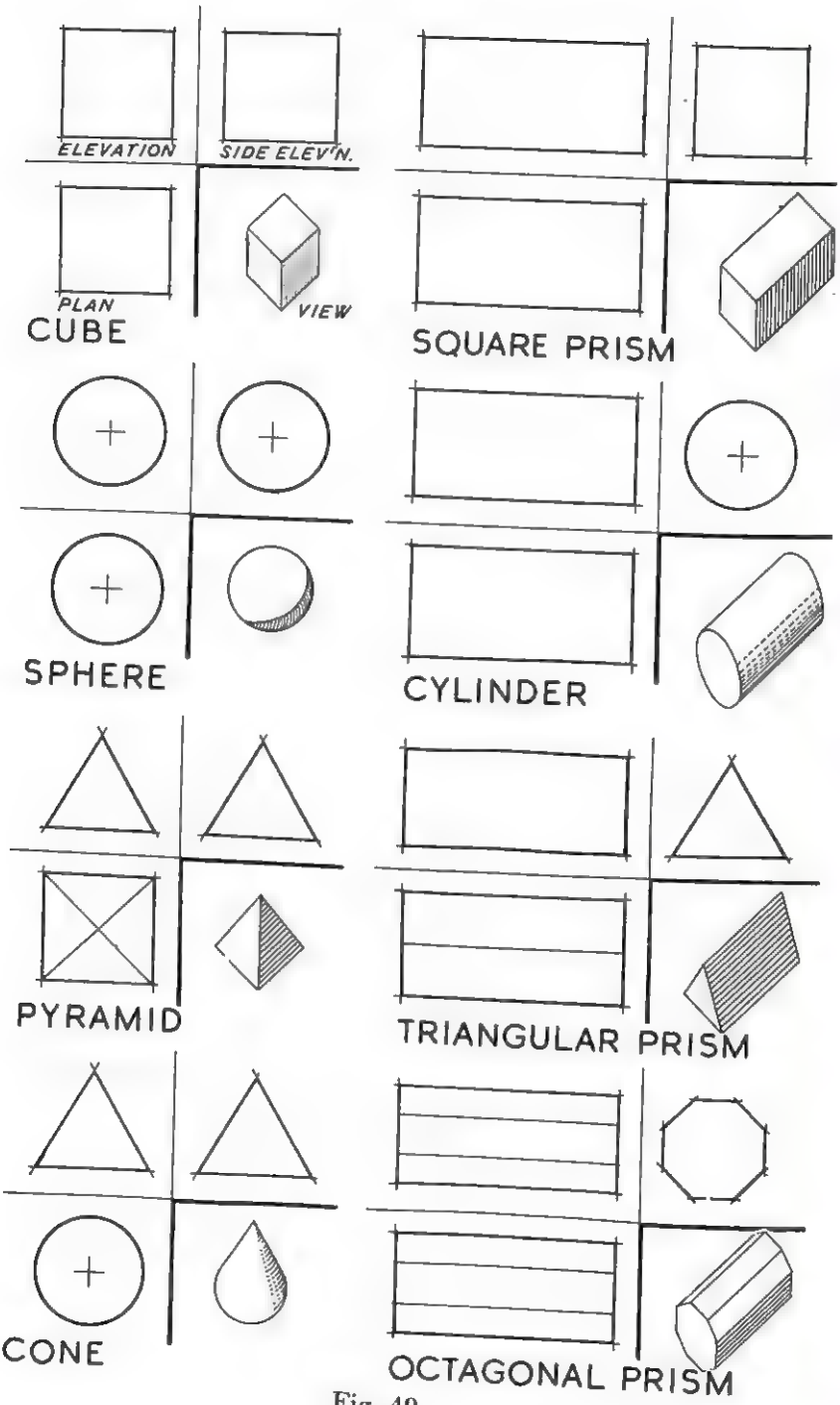

ELEVATION
SIDE ELEV'N.
PLAN
VIEW
CUBE
SQUARE PRISM
SPHERE
CYLINDER
PYRAMID
TRIANGULAR PRISM
CONE
OCTAGONAL PRISM

Fig. 49

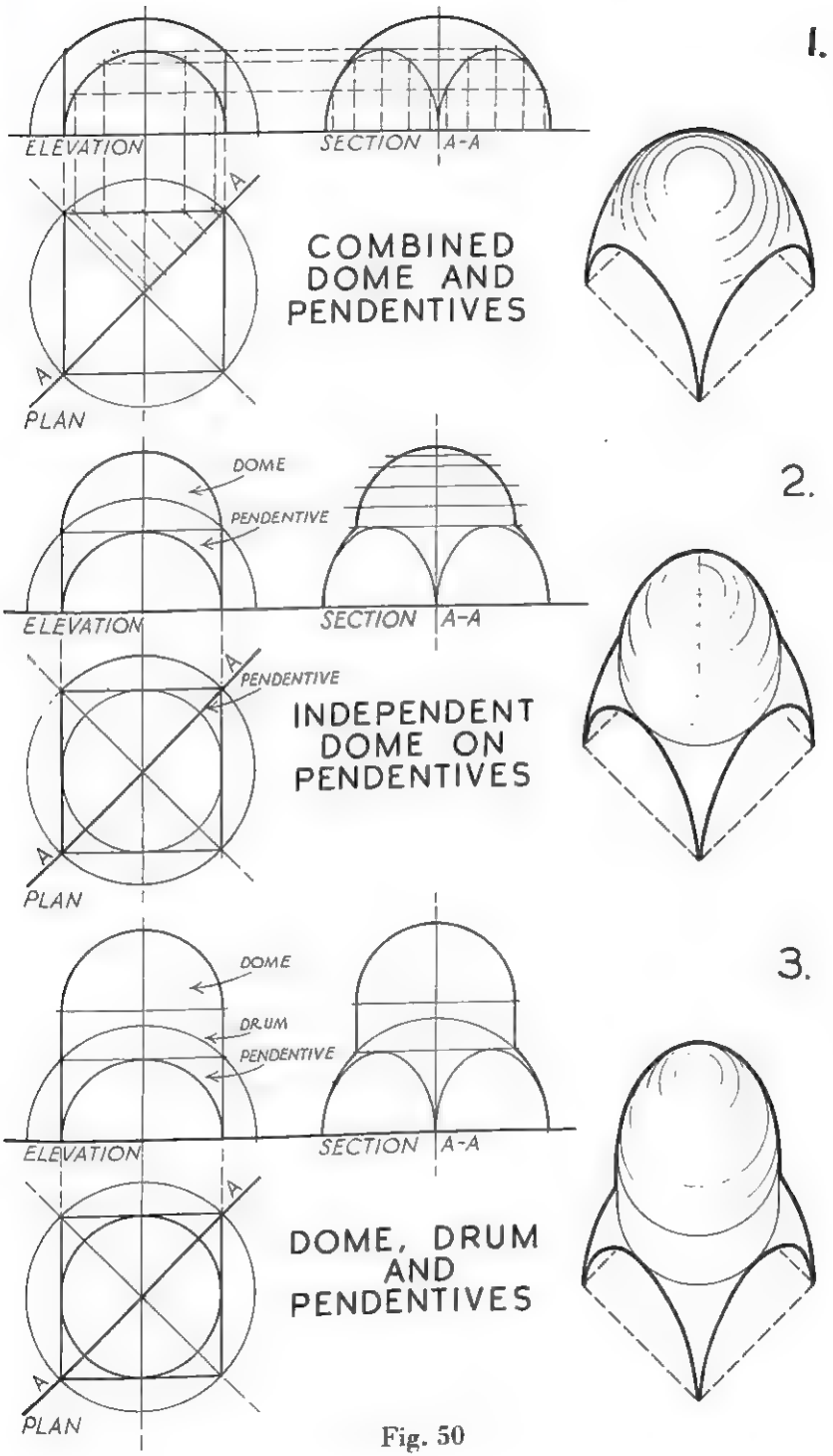

1.
ELEVATION
SECTION A-A
A
A
PLAN
COMBINED DOME AND PENDENTIVES
2.
DOME
PENDENTIVE
ELEVATION
SECTION A-A
A
A
PENDENTIVE
PLAN
INDEPENDENT DOME ON PENDENTIVES
3.
DOME
DRUM
PENDENTIVE
ELEVATION
SECTION A-A
A
A
PLAN
DOME, DRUM AND PENDENTIVES

Fig. 50

Inclined Cuts and True Sections

Without going into detailed explanations of the plotting of them, Fig. 51 shows examples of six geometric solids drawn in orthographic projection cut by inclined planes at 45 degrees. The true section or the new surface made by the cut is shown with a strong outline and is hatched in the pictorial view in each example.

Surface Developments

It is sometimes necessary to show graphically the total surface area of a solid opened out as it were into one plane, e.g. shapes to cut in sheet metal or to be covered in some material.

Fig. 52 shows a number of simple geometric solids developed in this way. The method is obvious in most cases. The surface of the cone is found by dividing the base on plan into a convenient number of parts and setting these off on an arc struck with its centre at the apex and radius equal to the inclined length in elevation. A similar method can be used for the cylinder, or the extent of the "unrolled" area can be calculated by multiplying the diameter of the ends by π or 3·141.

Fig. 53 shows the method of finding the surface developments of the "cloister" and "cross" vault forms, pictorial views of which are given. The projection lines show how the diagonal sections are set up as well as how the developments are plotted.

Roof Developments

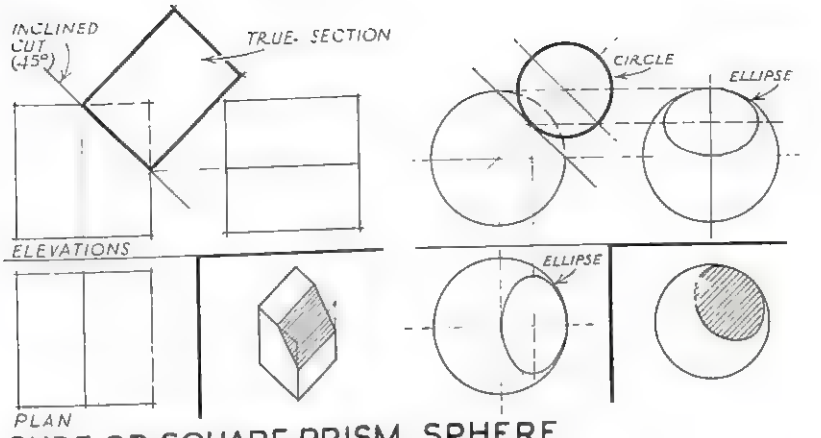
Fig. 54 shows two examples of the graphical development of pitched roof surfaces, which are not represented in true proportion in ordinary orthographic projection, i.e. in plan and elevation. By following carefully the projection lines and noting the indexing, the way in which the developed, i.e. the actual, shapes of the surfaces are obtained will be understood. Pictorial views of the roofs are given to show their general appearance.

Similar exercises for various kinds of pitched roofs should be carried out as part of the study of geometrical drawing.

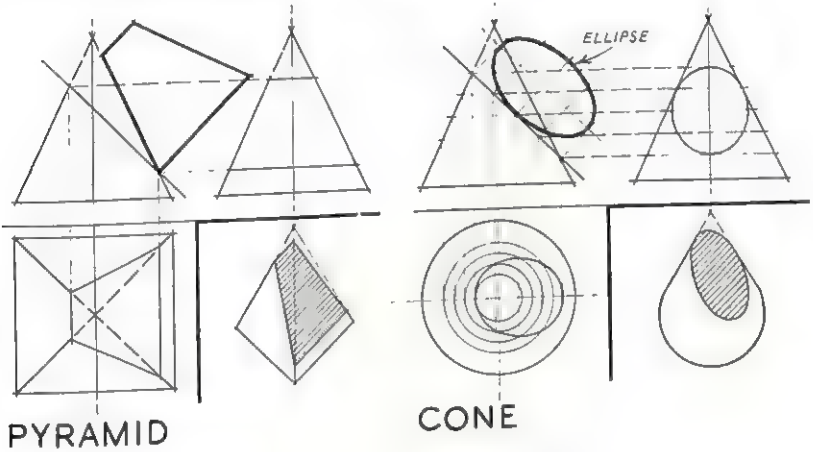
Spiral Curves

Fig. 55 shows examples of the drawing of spiral curves.

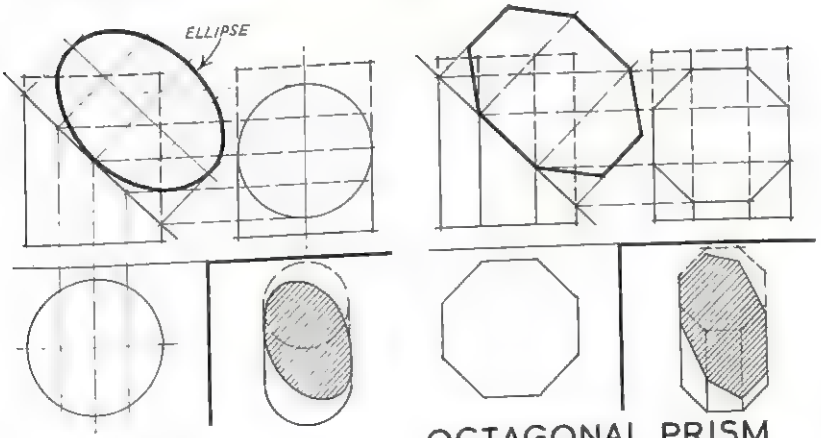
(1) A spiral about a cylinder or helix. This is the basis of the setting-out of a spiral staircase. The cylinder is shown in plan and elevation. The circumference on plan is divided into a number of equal parts, indexed 0-12 in the example, and the height on elevation is marked with a number of equal divisions. By projecting up from the plan points of intersection are found through which the spiral seen in elevation passes.



CUBE OR SQUARE PRISM SPHERE



PYRAMID CONE



CYLINDER OCTAGONAL PRISM

INCLINED CUTS AND TRUE SECTIONS

Fig. 51

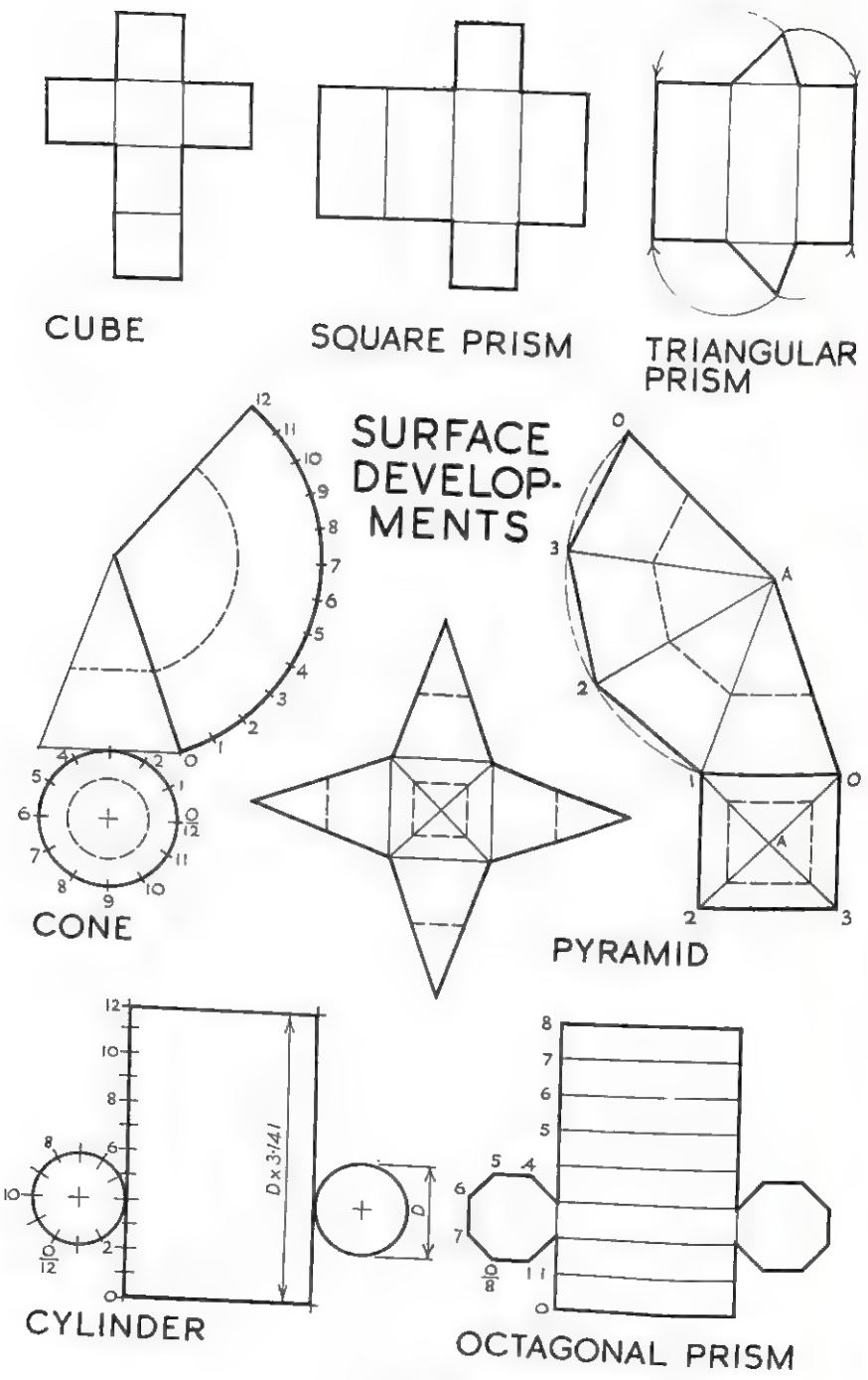
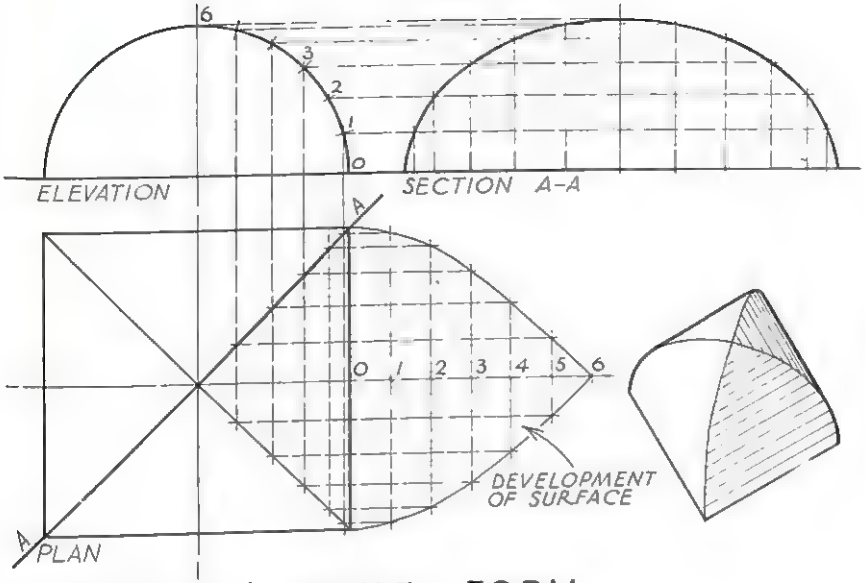
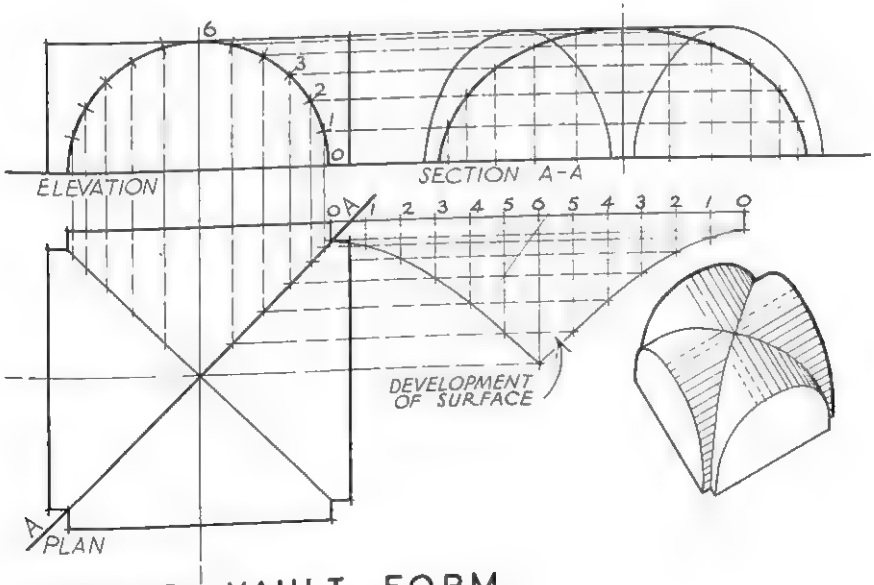

CUBE
SQUARE PRISM
TRIANGULAR PRISM
SURFACE DEVELOPMENTS
CONE
PYRAMID
CYLINDER
D x 3·141
D
OCTAGONAL PRISM

Fig. 52

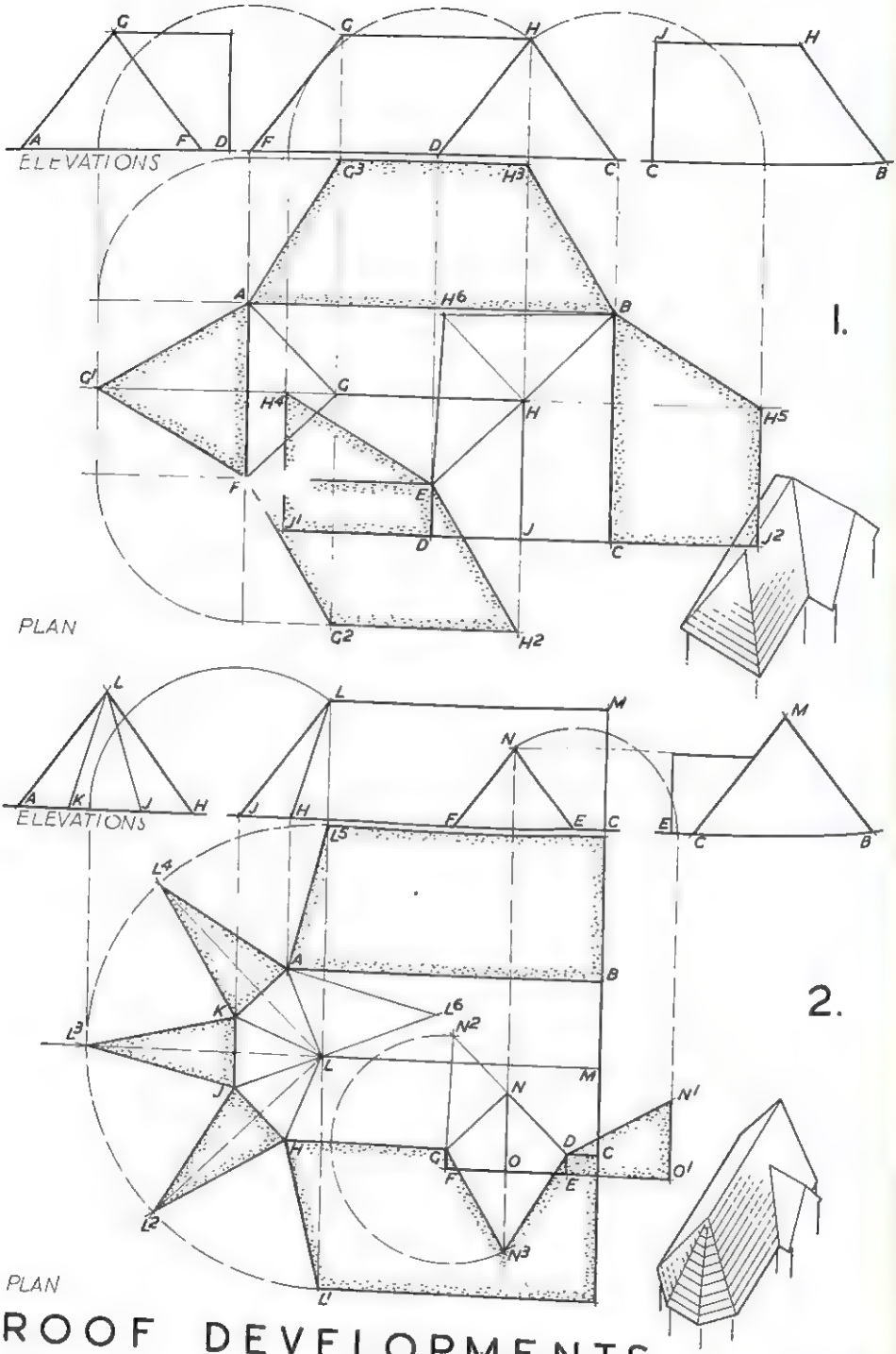


'CLOISTER' VAULT FORM



CROSS VAULT FORM

Fig. 53



ROOF DEVELOPMENTS

Fig. 54

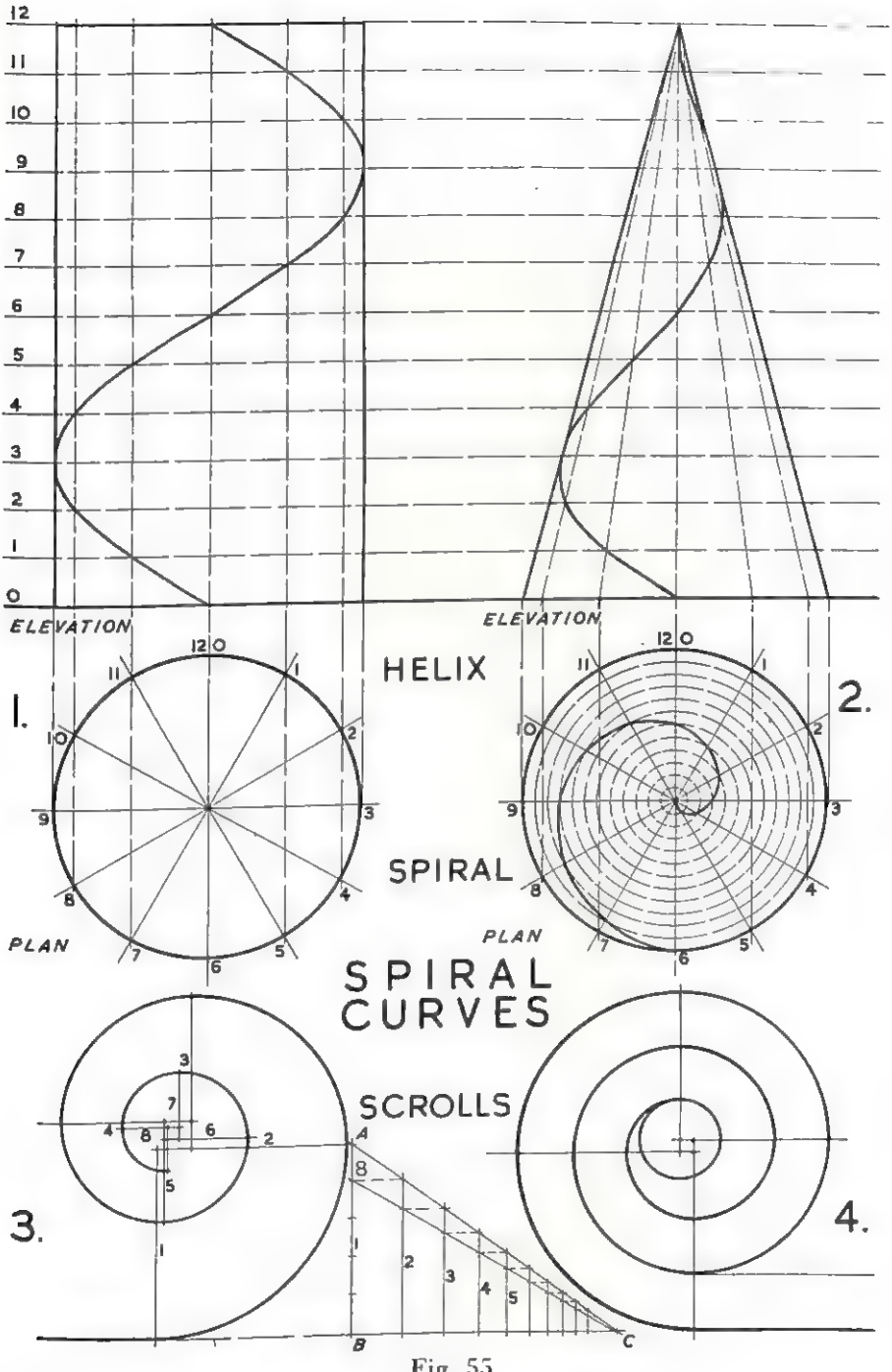

ELEVATION
ELEVATION
HELIX
1.
2.
SPIRAL
PLAN
PLAN
SPIRAL CURVES
SCROLLS
3.
4.
A
B
C

Fig. 55

(2) A spiral curve about a cone—this is a true spiral. The procedure to find the curve in elevation is similar to that for the cylinder. To find the curve on plan, draw concentric circles about the centre corresponding to the horizontal divisions on elevation. Join the points on the outer circumference on plan to the centre, and the curve can then be drawn through the appropriate intersections.

In addition to the various scrolls based on quadrants and the classical Ionic volute two other examples are:

(3) The method is: Assume *AB* to be the greatest radii required or given; this is indexed 1. At right-angles draw *BC* of convenient length and join *A* to *C*. Next, decide the number of radii to be used—this is a matter of judgment depending on the size of the scroll—10 are taken here. Divide *AB* into ten equal parts. At the eighth part draw a line parallel to *BC* intersecting *AC*, from the intersection draw a perpendicular to *BC*, this gives radius 2. Join point 8 to *C*, where this line intersects radius 2 draw a line parallel to *BC* to intersect *AC* and so obtain radius 3. By continuing in this manner the series of radii can be obtained reduced in geometrical progression.

To draw the scroll with these radii, each one is used to describe a quadrant, as shown in Fig. 55, as far as radius 8.

(4) A scroll drawn from four centres at the corner of a square by describing successive quadrants.

CHAPTER III

LETTERING

LITTLE progress can be made in draughtsmanship without attention being paid to lettering.

Almost every drawing has to be titled and many of them, particularly working drawings, require descriptive words and notes in order that they can be clearly understood. It is important, therefore, for the draughtsman of whatever category to acquire as quickly as possible the habit of using good lettering on all his work. And as the study of lettering also affords excellent practice in drawing it is particularly suitable that it should be dealt with at an early stage in the training.

With all lettering, the first principle is that of *Legibility*. Legibility depends on (1) shape or form of each individual letter, (2) spacing of letters and arrangement of words, and (3) the sizes and positions of the lettering according to relative importance. The second principle is that of suitability of shape to materials and method of execution; thus, lettering drawn in pencil on paper will differ in form to some extent from lettering incised in stone. Thirdly, the character of the lettering must be appropriate to its purpose. The type of letters and general composition of the wording should be expressive of the quality or use of the drawing, e.g. decorative lettering is completely out of place on a working drawing just as crude stencil lettering would be on a highly finished perspective drawing.

English lettering is derived from that of the Romans, and the generally accepted standard is the lettering which was carved on Trajan's Column, Rome, in the second century A.D. This lettering was probably first "painted" on the stone with a brush and then incised with a chisel, which procedure accounts to some extent for the forms and details, e.g. the thick and thin strokes from the brush-work, and the "serifs", originally the chiselled terminations of parts of the letters. Nevertheless, the forms have now become familiar in printed types, and "flat" letters and the Roman alphabet will always be the basis of good lettering.

The Roman Alphabet

There is, however, no absolute standard for Roman lettering, and many of the variations are not suitable for ordinary draughting purposes. The one shown in Fig. 56 has been specially prepared for drawings, bearing in mind the need for preserving

the essential shapes and for a simple setting-out. It is an alphabet which should be carefully studied, and the best way to study it is to draw it out, for the basic proportions. It can be used for the titling of important drawings.

The construction of each letter is shown and should be understood on examination. General points to be observed are: (1) all thin strokes are the same width, and all thick strokes—except the I and the J, which can be a little wider—are the same width. The thick strokes are about one-tenth the height of the letters; the thin strokes rather more than half the thick strokes; (2) the letters are all one height except the "points" of A, M, N, V and W, which extend, as do C, G, O and Q, a little beyond the limits in order to make them appear the right size (do not exaggerate this subtlety); (3) the middle line between the top and bottom guide-lines determines the position of parts of several of the letters as well as centres for C, G, O and Q.

Individual points are:

A — both sides inclined at 70 degrees, the bottom of the cross-bar is midway between the middle and bottom guide lines.
B — explained by drawing; construction lines are at 45 degrees; centres of arcs are indicated by dots; arrows indicate radii.
C — outside curve is part of circle; inside curve is struck from centres indicated; axes at $22\frac{1}{2}$ degrees and $67\frac{1}{2}$ degrees to horizontal; widest parts rather wider than wide parts of thick strokes, same with G, O, and Q.
D — explained by drawing, note width of letter, about $\frac{3}{4}$ of height.
E — based on double square; note slight curve and slope of serif to top of lowest arm—same with L.
F — similar to upper part of E.
G — similar basis to C; note position of vertical stroke, determined by intersection of 45 degrees line from centre with outside curve—compare with C.
H — explained by drawing.
I — explained by drawing.
J — centres for arcs can be judged by eye; curve must be smooth and regular.
K — curve to lower leg is drawn freehand, points must not become "hook"—same with R.
L — similar to lower part of E.
M — explained by drawing.
N — explained by drawing.
O — similar construction to C.
P — explained by drawing.
Q — similar construction to O; note positions along axis for centres of arcs for tail.
R — similar construction to P, but note junction of inner curve at top and junction between vertical stroke and leg; the leg should not be "curly".
S — explained by drawing; careful drawing necessary.
T — explained by drawing.
U — explained by drawing; foot can be omitted.
V, W, X, Y, Z — explained by drawing.

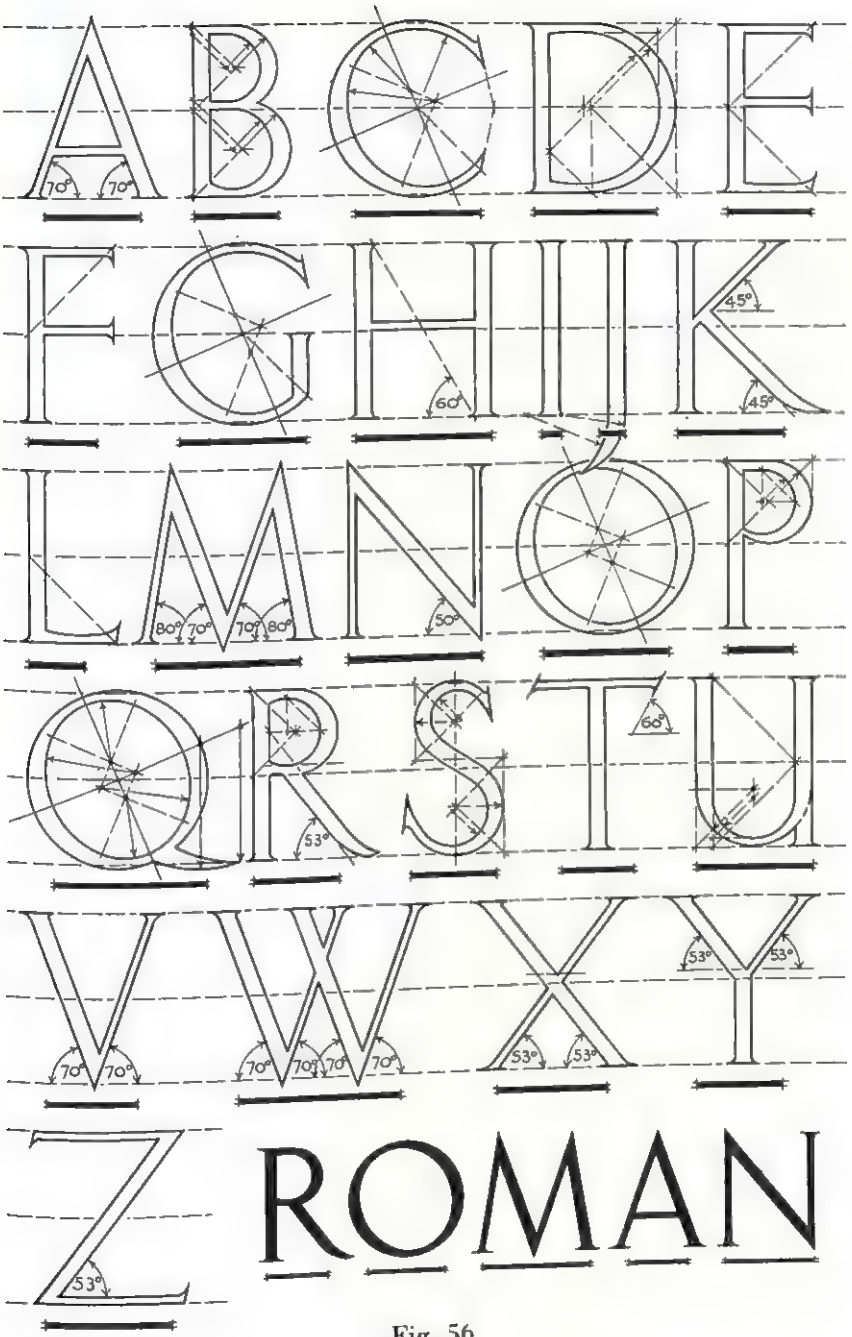

ABCDE
70°
70°
FGHIJK
60°
45°
45°
LMNOP
80°
70°
70°
80°
50°
QRSTU
53°
60°
VWXY
70°
70°
70°
70°
70°
70°
53°
53°
53°
53°
Z
53°
ROMAN

Fig. 56

It is only possible to use the setting-out fully if the letters are drawn to a reasonably large size. For small letters, while the angles can be followed, some parts have to be drawn freehand by eye instead of with compasses.

"Serifs" must be neatly formed and smoothly joined up with the rest of the letter, and should be put in before the final lines are completed.

Fig. 57 shows the stages in setting up three letters: (1) The guide-lines and principal construction lines are drawn lightly, (2) the letters are lightly completed and the serifs drawn in freehand in the final line, (3) the letters are completed in the final line, curved lines being put in before straight lines in the case of B. *This procedure should be followed in general in making any drawing.*

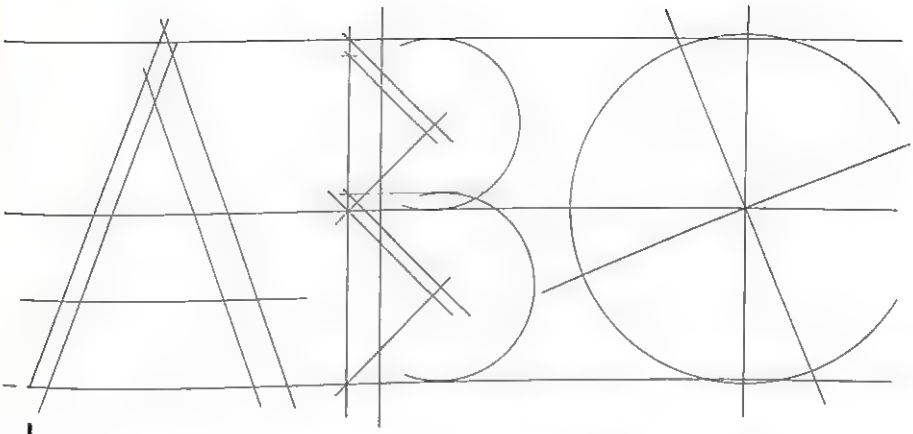
The spacing of letters to form words can vary considerably within limits depending upon space available, purpose, and so on. Because the individual letters differ in shape the spacing has to be arranged to avoid crowding in some parts of words and too wide spacing in others. Until the eye becomes trained a useful guide to spacing is given by the thick black lines shown under each letter in Fig. 56. The line in each case can be taken as representing the "value" of the letter according to its shape and size; the letters are then spaced so that the distances between these value lines are equal, as illustrated by the word "ROMAN". This method need not be rigidly adhered to; some variations may have to be made at times to suit circumstances.

Titles of important drawings should always be set out on tracing paper to get the size and spacing right before being drawn on the final sheets.

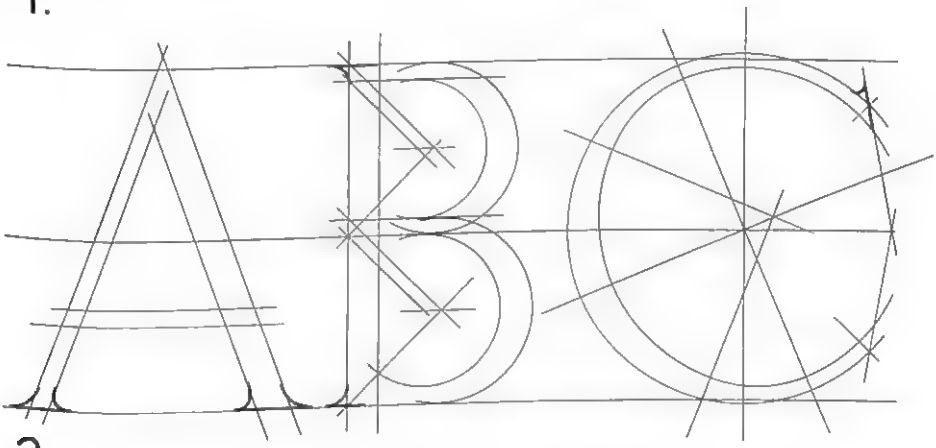
Sans Serif Letters

In more recent times letters without serifs, known as "sans serif" alphabets, have been designed and are much used because of their simplicity, clarity and ease of execution. Fig. 58 shows the setting-out of such an alphabet[1] suitable for the titling of drawings, etc. The letters are formed of strokes all equal in thickness. One-tenth the height is an average thickness of the strokes, but it can be more or less according to the effect required. The thicker the stroke, the heavier or bolder the letter. The letters are all the same height. Suggested value lines for spacing are shown as in the case of the Roman alphabet.

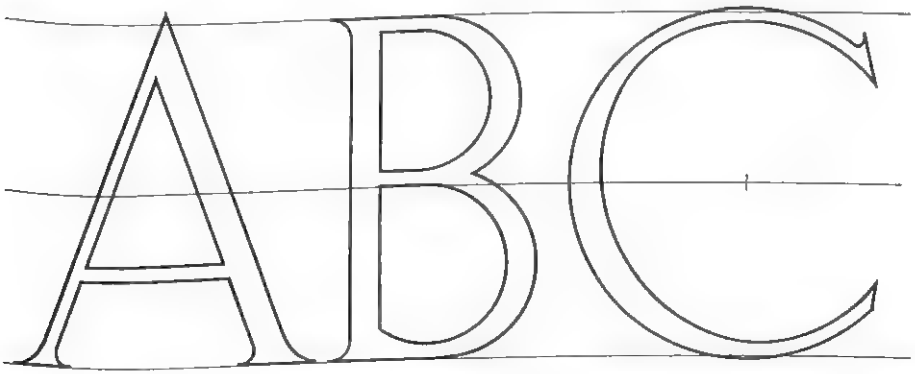
[1] Based on "Gill Sans", a printing type designed by Eric Gill for the Monotype Corporation.



1.



2.



3.

Fig. 57

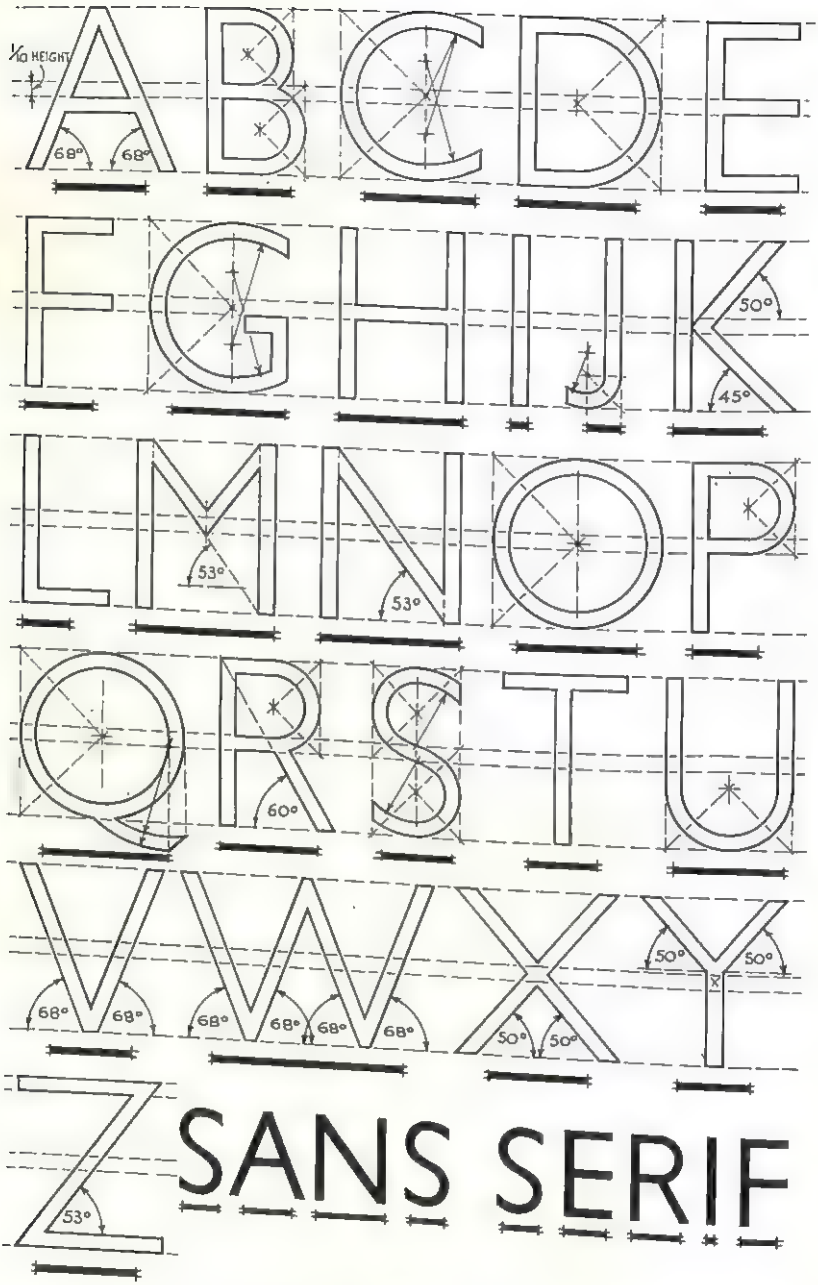

1/10 HEIGHT
68°
68°
50°
45°
53°
53°
60°
68°
68°
68°
68°
68°
68°
50°
50°
50°
50°
53°
SANS SERIF

Fig. 58

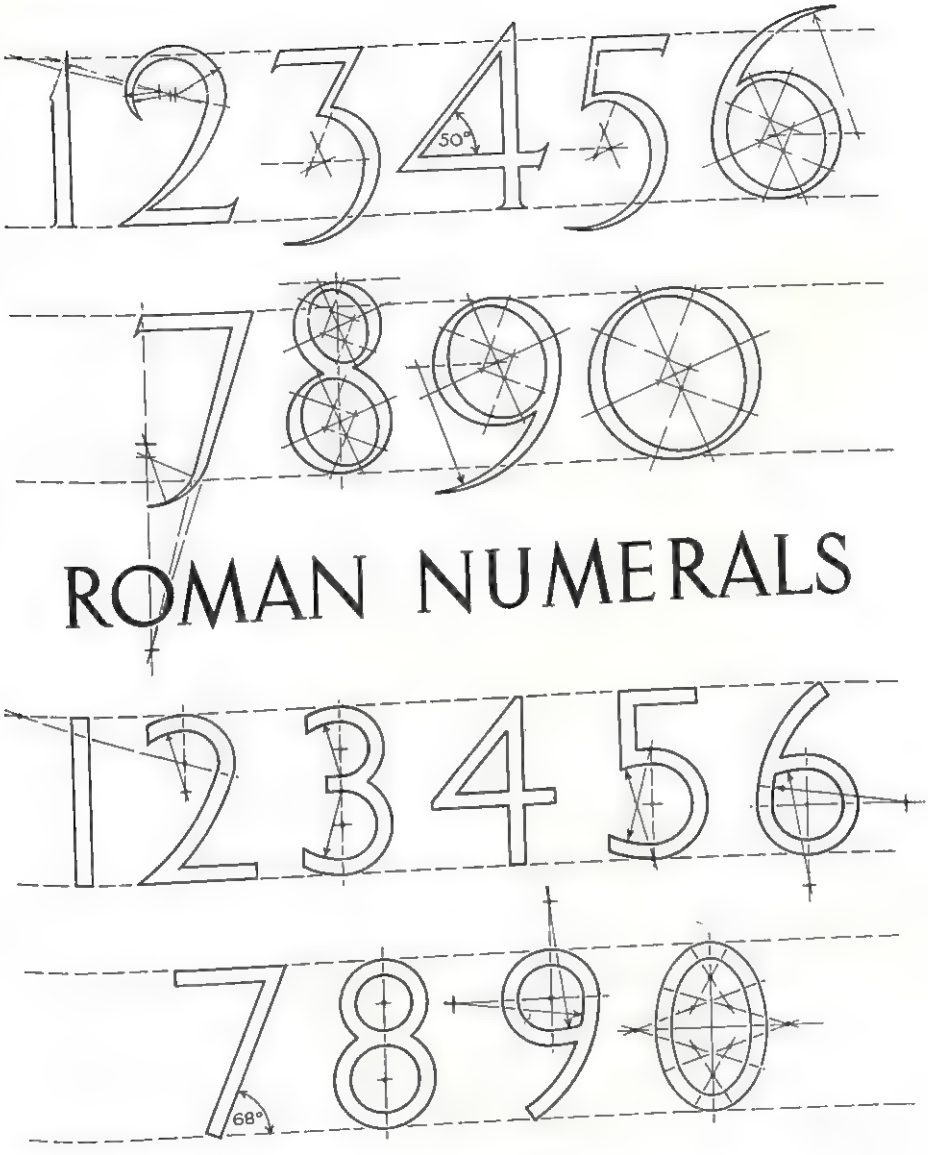


Fig. 59

Numerals

Fig. 59 shows the setting-out of Roman and Sans Serif numerals. Regarding the former, the Roman did not, of course, use numerals of this kind, which are Arabic in origin, but the character of Roman lettering is followed and the shapes are based on those in common use for many years.

Single-line Lettering

For habitual rapid use in labelling and putting notes on drawings, a single-line alphabet is required. This should be based on the shapes and proportions of the "Roman" letters, but without the use of serifs.

Fig. 60 shows such an alphabet and corresponding numerals. In order to illustrate the shapes and proportions, guide-lines dividing the height into eight equal parts and the centres of arcs are indicated. The lettering should, however, be drawn freehand at various sizes, e.g. 1″, $\frac{1}{2}$″, $\frac{1}{4}$″ and $\frac{1}{8}$″ high.

It will be found, at first, that each letter has to be formed carefully and comparatively slowly to avoid distortion and wrong shapes. With practice, however, it is soon possible to letter quickly and accurately without conscious effort.

After a time certain individual characteristics will be acquired, but avoid the deliberate introduction of novel or fancy shapes in the mistaken idea that doing so imparts "style". Legibility and seemliness are far more important than individual idiosyncrasy.

Always rule faint guide-lines for freehand lettering and keep to them. Use a reasonably soft pencil.

Inclined Lettering

Sometimes it is necessary to distinguish between two types of lettering, e.g. names of rooms on plan and notes regarding construction. While this might be effected by variations in size, it may be more convenient to use upright lettering for the one and inclined lettering for the other.

Fig. 61 shows inclined lettering similar in all respects otherwise to the single-line lettering above, but sloping uniformly at an angle of about 75 degrees. The slope should not be exaggerated.

Many draughtsmen use inclined lettering for general use in preference to upright. It is a matter of personal choice. Almost always the lettering is done in capital letters; small or "lower case" letters are only used in connection with "decorative" lettering such as the following examples.

Fig. 60

ABCDEFGHIJKLMNOPQ
RSTUVWXYZ 1234567890

Fig. 61

ABCDEFGHIJKLMNOPQ
RSTUVWXYZ 1234567890
abcdefghijklmnopqrstuvwxyz

Fig. 62

ABCDEFGHIJKLMNOPQ
RSTUVWXYZ 1234567890
abcdefghijklmnopqrstuvwxyz

Fig. 63

Script Lettering

Fig. 62 shows capitals, numerals and lower-case letters as can be written in pencil or with an ordinary freehand pen. Script lettering is less used nowadays, but if well executed is still an attractive way of labelling certain presentation drawings.

Broad Pen Lettering

This lettering has similar uses to the above. Fig. 63 is an example of it. It can only be done in ink and a special broad nib has to be used. There are many kinds on the market; full instructions can be obtained with them.

Special Lettering

Some drawings, particularly design drawings, perspectives, exhibition, measured drawings, etc., may be more appropriately titled in lettering of a character in keeping with that of the subject. Care must be exercised in the selection. Fig. 64 illustrates some varieties of lettering of this kind, some of them adapted from modern type faces. It is a good plan to collect suitable examples from magazines, advertisements, etc., and keep them in a scrap-book for reference.

Bad Lettering

As a contrast to the foregoing, some bad examples of lettering are shown in Fig. 65. All these have been taken from books still in current use on technical drawing!

Stencil Lettering

Stencilled lettering is used for the titling of architectural and other drawings, especially where a number of drawings all have the same title. Fig. 66 shows examples of the letters and how they are stencilled. The stencils are cut in thin copper or, preferably, in celluloid, and can be obtained in either "Roman" or block alphabets in sizes from $\frac{1}{8}$" to 1" high. The advantage of the celluloid plates is that a guide-line drawn on the paper can be seen through them. It is usually better to space out the letter fairly widely and regularly. Special stencil ink can be used or Indian ink or poster colour, etc. The brush must be almost dry and the plate held down perfectly flat and firmly for good results. A little experiment shows the best way.

"Uno" Pen Lettering

Fig. 67 shows examples of the letters produced with the special "Uno"[1] pens and guides. The lettering is now used extensively

[1] "Uno" pen stencils. (A. West and Partners, Ltd., Westminster, London, S.W.1.)

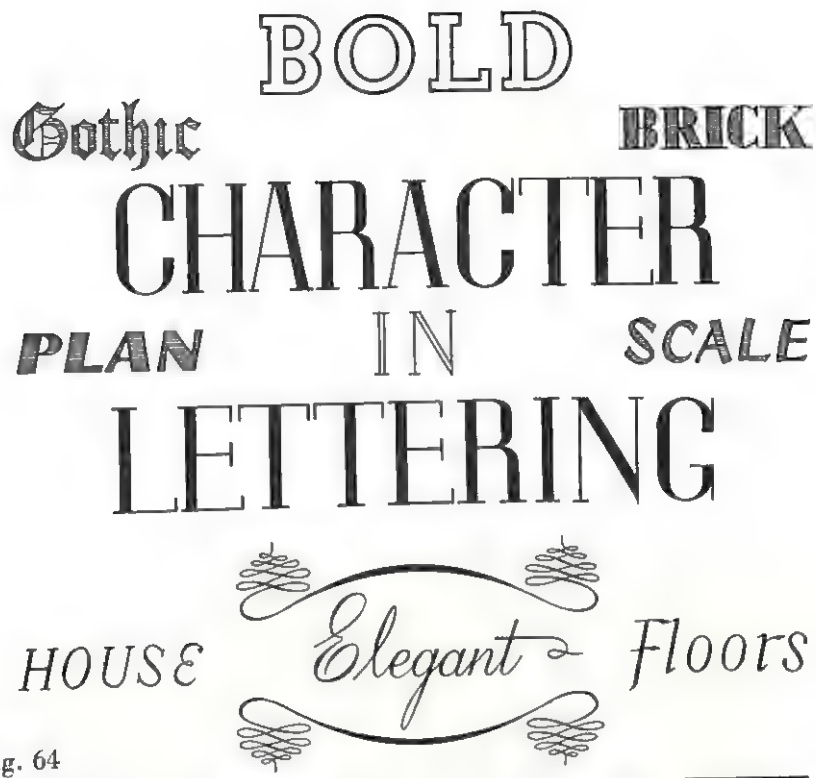

BOLD
Gothic
BRICK
CHARACTER
PLAN
IN
SCALE
LETTERING
HOUSE
Elegant
Floors

Fig. 64

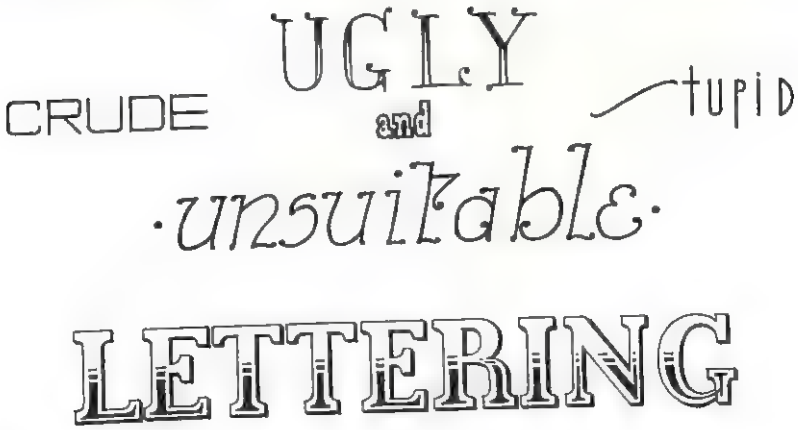

UGLY
CRUDE
and
tupid
unsuitable
LETTERING

Fig. 65

ABCDEFGHIJKLM
NOPQRSTUVWXYZ
1234567890 №&
ABCDEFGHIJKLM
NOPQRSTUVWXYZ
1234567890 №&

Fig. 66

ABCDEFGHIJKLMN
OPQRSTUVWXYZ
1234567890No/&
abcdefghijklm
nopqrstuvwxyz
1234567890No

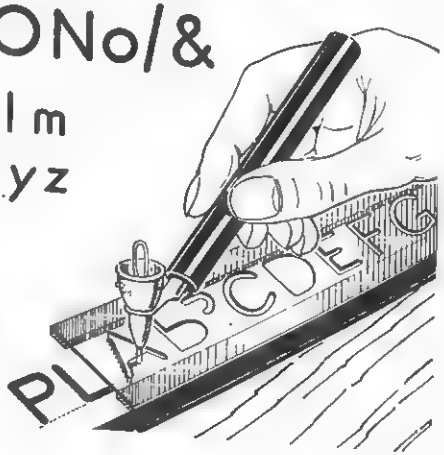


Fig. 67

for drawings of all kinds, particularly working drawings and details. Its popularity is due to its legibility, speed of execution, and the uniformity which it gives, especially when different draughtsmen are working on the same set of drawings. Examples are also to be found in the illustrations used throughout this book.

Both upright and sloping guides are obtainable for capital, lower-case letters and numerals in a variety of sizes with corresponding pens. The very smallest size is too small for most draughtsmen to manipulate and has no particular advantages, but sizes 2, 3, 4, 5 and 6 meet most requirements.

Used carelessly, this lettering is as bad as the worst freehand and a certain amount of practice is necessary to obtain lettering which is pleasing in appearance as well as most legible.

A few hints are: (1) only a small quantity of ink should be put in the pen, (2) keep the pen perfectly upright in use, (3) wash the pen out immediately after use and see that the wire is pushed well home, (4) keep the guides clean, do not let the ink clog the letters. A special cleaning liquid can be obtained for pen and guides.

Always rule faint guide-lines for letters and consider the spacing before starting. Sometimes it may be advisable to make a trial setting-out.

Notes

Notes on drawings are of two kinds: (1) those of a general nature, and (2) those which refer to some detail in particular. The former should be grouped together in a suitable position and neatly arranged in panels of regular shape, Fig. 68.

They should be broken into paragraphs corresponding to the matters dealt with for ease in reading. They should be as brief as possible consistent with clarity. Spacing should be considered in relation to balance and the scale of the drawing, but avoid cramping the letters and words or spreading them out so much as to make them illegible. The spaces between the letters should generally be less than the spaces between one line of notes and the next, otherwise the eye tends to read vertically, "Chinese" fashion.

Detail notes should be reasonably small and neatly arranged close to the part of the drawing to which they refer. A short arrow as pointer should be all that is necessary to connect the note to the detail. Do not group detail notes if to do so means long "snaky" arrows or lines to relate them to the drawing. Do not use "keys", that is, for example, numbering the rooms on a plan and then putting a list explaining what the numbers mean at the side of the drawing unless lack of space or other reason makes such a course imperative.

If words have to be shortened, try to preserve clarity without resorting to objectionable abbreviations such as "kitch." for kitchen, "kit." is better; "L.R." for living-room rather than "Liv. Rm." See p. 100 for common abbreviations of building terms.

Words should only be underlined where special emphasis is required. Full-stops should not be used unless essential to the sense of the note.

North-Points

The purpose of a north-point on a drawing is to show the position of north in relation to the plan of a site or a building. It should therefore be on or near to the plan and should be clearly read, that is, be simple as well as accurate. Fig. 68 shows three typical examples which are suitable for general requirements. The simple cross for sketches and unpretentious drawings and the V or arrow for more important sheets. The letter "N" should be shown in all cases. Elaborate north-points are only justified in exceptional circumstances.

Types of Lines

Fig. 68 also shows various lines used on drawings.

Construction or setting-out lines are made as light as possible, and finished lines are strong and of even quality, as described previously.

Where it is required to show the lines of some object which is under or behind some other part or, in the case of plans, is above the level at which the plan is taken, broken lines are used consisting of regular short dashes separated by regular gaps, the lines being appreciably longer than the gaps. "Dotted" lines should not be used.

Projection lines should be light like construction lines, but broken by regular gaps.

Centre lines or axes (axial lines) are usually shown by comparatively light continuous lines with a short gap and short line at each end. An alternative line for this purpose recommended by the British Standards Institution is one consisting of alternate long and short lines separated by regular gaps, as shown in the figure for overhead R.S.J.'s, etc. Centre lines should project a short distance beyond the outlines of the part to which they refer.

Where it is intended to show that a drawing is incomplete, break lines consisting of ruled lines with short zig-zags at intervals are used.

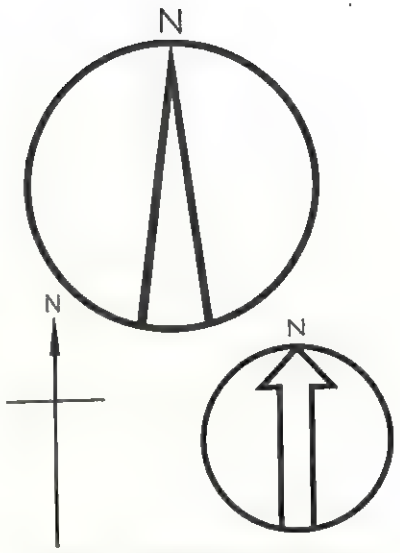
Section lines, which indicate where a plan has been "cut" (see Chapter II) are commonly shown by either of the ways

NOTES

GENERAL NOTES SHOULD NOT BE SCATTERED OVER THE DRAWING BUT SHOULD BE NEATLY ARRANGED IN PANELS OF REGULAR SHAPE

THEY SHOULD BE BROKEN INTO PARAGRAPHS FOR EASE IN READING.

THE LETTERS AND WORDS SHOULD NOT BE CRAMPED NOR SO W I D E L Y SPACED AS TO BECOME ILLEGIBLE



TYPICAL NORTH POINTS

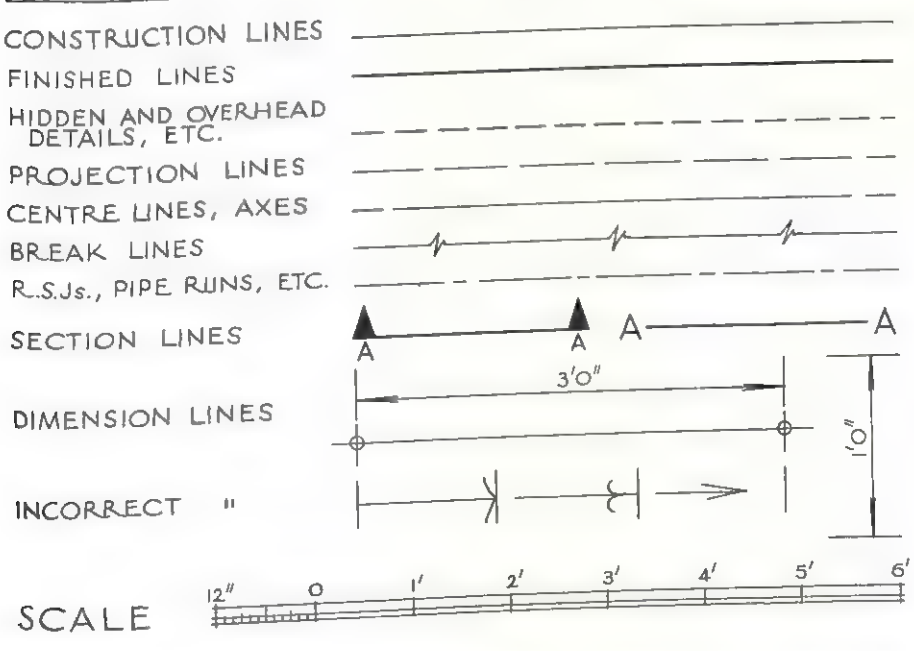


Fig. 68

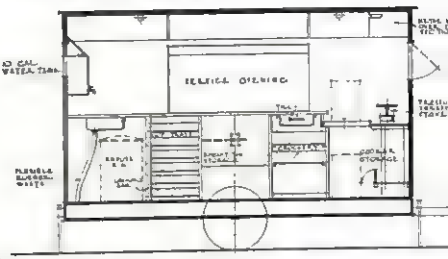
illustrated. The black triangles or the placing of the letters show the way the sectional view is taken.

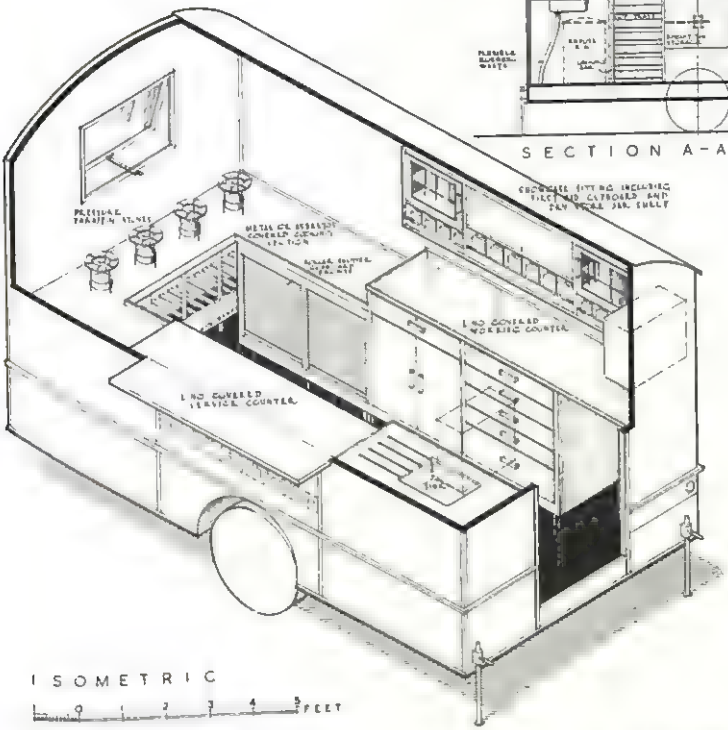
Dimension lines (see also p. 124) should be lighter or thinner than outlines and should be continuous, not broken for the insertion of dimension figures. They should be terminated by sharp arrow-heads exactly touching the outlines or projection lines to which they relate, or the dimension lines can be continued past the outlines and projection lines and the points of intersection emphasised by a small circle or dot. Dimension figures should be placed immediately above the corresponding dimension line, either near the centre or at the extreme left. The figures should always be disposed along the line and not at right-angles to it. Vertical dimension lines should have the figures on the left-hand side reading upwards.

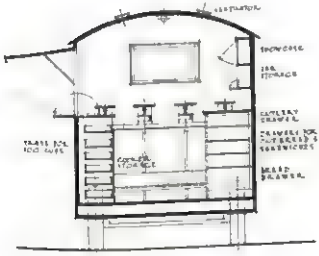
Scales

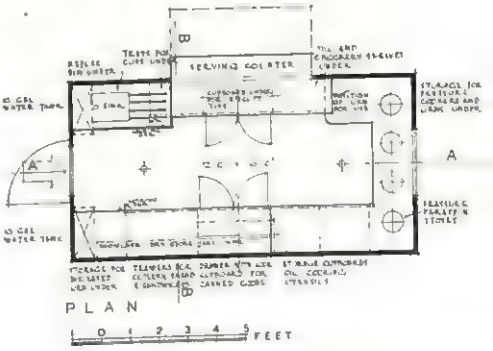
When drawn scales are used—and it is the usual practice now not to do so unless the drawing is to be reproduced to a different size—they should be simple and easy to read. Three parallel horizontal lines with vertical subdivisions in the manner shown in Fig. 68, and with the major units to the right and minor units to the left is a satisfactory arrangement. The scale should also be written in words.

MOBILE KITCHEN









CHAPTER IV

SCALE DRAWING

THE majority of technical drawings are *scale drawings*, that is, the land, buildings or objects shown on them are not represented at their true size, but are larger or, more often, smaller in some proportion.

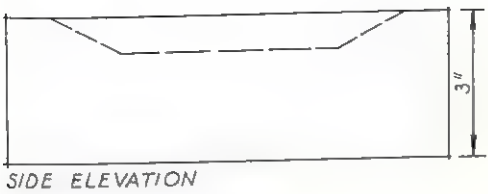
Fig. 69, for example, is a scale drawing of a brick, which is taken as measuring 9″ long, 4½″ wide and 3″ high. It is shown in orthographic projection consisting of plan, side elevation and end elevation to a scale of 3″ represents 1′ 0″ or quarter full size, the measurements of the brick on the drawing being 2¼″ long by 1⅛″ wide by ¾″ high. However, its true size is made clear by the writing of the scale on the drawing, by the drawing of a scale showing inches in proportion to the drawing, and by the putting of dimension lines and figures in relation to the plan and elevation.

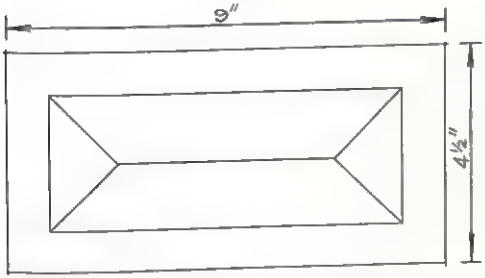
Note how the "frog" or depression in the top of the brick is shown in the drawing.

Fig. 70 shows a portion of a 9″ thick brick wall in plan, elevation and section drawn to a scale of 1″ represents 1′ 0″. The wall is assumed to be built up of bricks exactly 9″ by 4½″ by 3″ and the joint thicknesses are ignored. The arrangement of the bricks is what is known as "English Bond". As the section does not refer to any particular part of the wall, it is unnecessary to show a section line on plan. In this drawing the drawn scale shows feet and inches to the scale used, and if it is desired to find any distance not dimensioned it can be taken off with dividers and measured along this scale. Alternatively, a box-wood scale, p. 11, could be used and by holding against the drawing the required distance can be measured along its edge to the appropriate scale.

Fig. 71 is a scale drawing of a stool in which 1½″ represents 1′ 0″. Note that the plan drawing consists of (1) a half-true plan looking down, and (2) a half-horizontal section through the legs. This method enables more details to be illustrated without repeating unnecessarily similar parts of the drawing. The sectional parts of the wood are defined more clearly by hatching between the outlines—see Chapter V.

Fig. 72 shows a scale drawing of a small garage in orthographic projection consisting of plan, two elevations and two sections. The scale is 1″ represents 8′ 0″, usually known as ⅛″ scale (not to be confused with eighth full size). A pictorial drawing, not

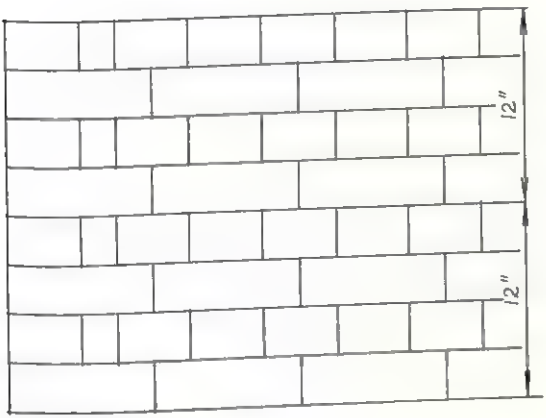


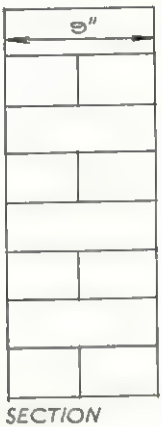


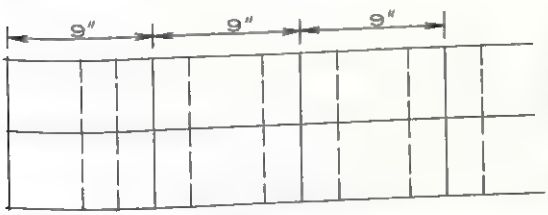
SCALE DRAWING OF A BRICK

Fig. 69

¼" REPRESENTS 1" OR QUARTER FULL-SIZE







SCALE DRAWING OF PART OF A BRICK WALL

Fig. 70

1" REPRESENTS 1'0"

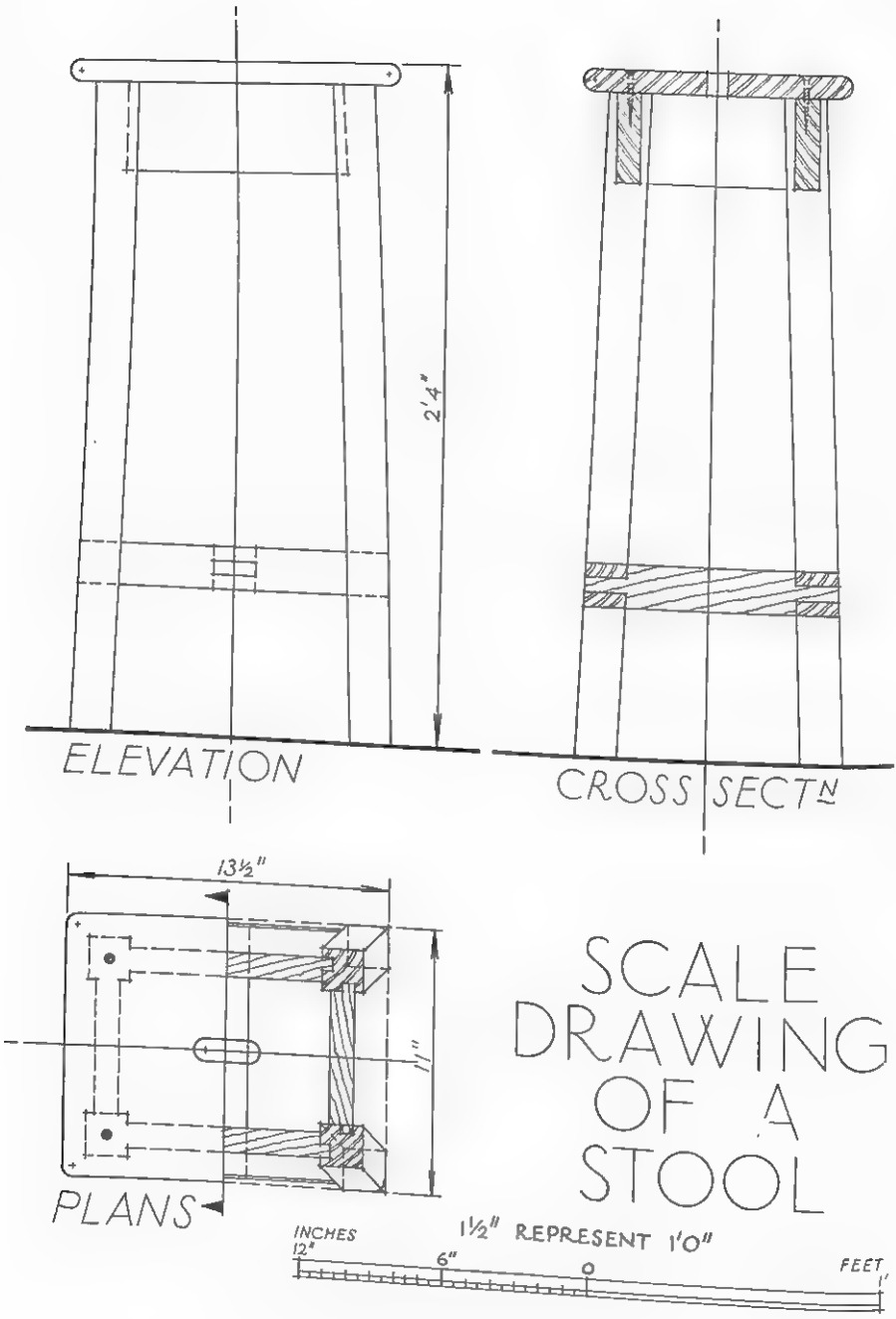

2'4"
ELEVATION
CROSS SECTN
13½"
11"
PLANS
SCALE DRAWING OF A STOOL
INCHES
12"
6"
0
1½" REPRESENT 1'0"
FEET
1'

Fig. 71

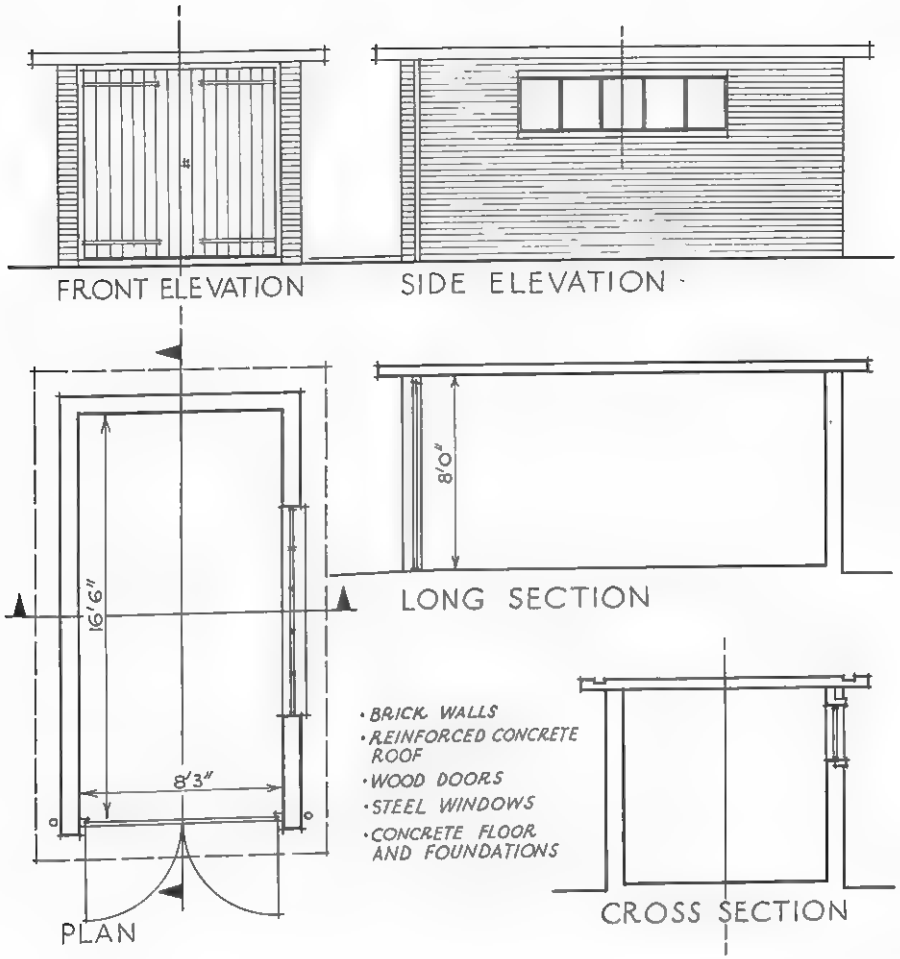

FRONT ELEVATION
SIDE ELEVATION
8'0"
LONG SECTION
16'6"
8'3"
PLAN
• BRICK WALLS
• REINFORCED CONCRETE ROOF
• WOOD DOORS
• STEEL WINDOWS
• CONCRETE FLOOR AND FOUNDATIONS
CROSS SECTION
SCALE DRAWING OF A SMALL GARAGE
EIGHTH INCH SCALE
INCHES
FEET
0
5
10
15

Fig. 72

to the same scale, is included to show the general appearance of the garage. Note the representation of the brick walls on elevation by the horizontal lines of the courses, and of the vertical boarding of the doors. The conventional representation of certain other features, some of which occur here, are explained in the next chapter. As the drawing is not intended, however, as a working drawing, constructional details are omitted.

Scales

Normally, such drawings as the ones above would be made using an appropriate boxwood or ivory scale for marking off the required distances. Only if it were necessary to work to some unusual proportion would a scale have to be drawn at the outset by dividing a line into whatever units and subdivisions were required.

The following are the chief scales for various kinds of drawings:

Land, towns, estates, sites (*Town Planning and Surveying*)

As used on Ordnance Maps:

Whole country	General map of United Kingdom	1 inch to 1 mile ($\frac{1}{63360}$).
	County Maps	6 inches to 1 mile ($\frac{1}{10560}$).
	Cadastral or Parish Maps	25 inches to 1 mile ($\frac{1}{2500}$).
Special Towns		500 inches to 1 mile ($\frac{1}{500}$).
London		60 inches to 1 mile ($\frac{1}{1056}$). (88 feet to 1 inch).

Town and Country Planning

Scales for schemes vary. Usually shown on 6″ Ordnance maps, giving extent, boundaries, contours, etc., with detailed zoning of urban areas on 60″ (London) or 25″ (country) maps. Statutory Town Planning Schemes are shown at 25″ scale, contours being shown. Regional and Civic Surveys are usually shown on 1″ maps for large areas or 6″ maps for areas of limited extent.

Surveys

Surveys are plotted at scales of 1, 2, 3, 4, 5 and 6 chains to 1″. Boxwood scales for each of these are obtainable, marked with chains along one edge and corresponding feet along the other. These scales are close divided and are often provided with short lengths of the same dividing, known as "offset" scales, for measuring and plotting at right-angles to the main scale.

For the drawing of estate surveys and site plans the scales of 88′ and 44′ to 1″ are commonly used. The latter is the minimum scale usually required by Local Authorities for block building and drainage plans. The natural scale of 1/500 or 41·6 ft. to 1 in. is also sometimes used. Boxwood scales with appropriate divisions are obtainable for the above.

Buildings and Building Sites (Architecture)

Lay-out of small sites, block plans, and, for extensive schemes, block elevations, sections and metric projections	32′ to 1″
Sketch plans; plans, elevations and sections of large buildings; some presentation drawings	16′ to 1″
Normal scale for plans, elevations and sections of buildings, particularly working drawings (Building plans required by Local Authorities to be not less than $\frac{1}{8}$″ scale, unless very extensive scheme when $\frac{1}{16}$″ scale accepted).	8′ to 1″
Plans, elevations and sections of small buildings	4′ to 1″ ($\frac{1}{4}$″ scale)
Details of buildings, particularly for working drawings ($\frac{3}{8}$″ and $\frac{1}{4}$″ scales are sometimes used instead, but tend to give false impressions to the reader who has become accustomed to the more usual $\frac{1}{2}$″ scale).	2′ to 1″ ($\frac{1}{2}$″ scale)
Isolated details which cannot be clearly shown at a smaller scale	1′ to 1″ (1″ scale) and 1$\frac{1}{2}$″ and 3″ scales (eighth and quarter full size).
Workshop drawings of details	Full size.

Types of Drawings

Reference has been made above to various types of drawings and the nature of some of them is amplified below. So far as drawing technique is concerned, there is no fundamental difference between the requirements of Planning, Surveying, Architectural and Building practice. There are certain minor differences in representation and conventional indication, but most of these are gradually disappearing, and a good draughtsman experiences no difficulty in dealing with all of them.

Planning Drawings

Under this general category may be included a number of types such as drawings and diagrams made to show the existing topography, roads, population, development, etc., preliminary schemes on broad lines to show proposed new roads and zoned areas, statutory scheme maps, and detailed new development lay-outs. Most of these drawings are prepared on or over Ordnance maps, which may in some cases have to be brought up to date. As the scales used are small and slips may therefore be comparatively large errors, particular care should be taken with the drawings, which must be neat and accurate on Scheme maps.

Full particulars as regards the preparation of planning maps is given in a *Memorandum* published by the Ministry of Town and Country Planning. In other respects, the methods and technique are as generally described throughout this book.

Survey Drawings

Good-quality paper which will take ink and colour is necessary for survey drawings. The size of the paper will depend on the size and scale of the area to be plotted: it is generally advisable to allow for a reasonably wide margin around the sheet.

In arranging the drawing it is only essential for true north to be at the top of the sheet when an extensive area is to be mapped; normally the approach to the area should be at the bottom of the sheet with any important road running approximately horizontally across the paper. Owing to the irregular outline of most areas, careful thought has to be given to the best placing of the survey on the sheet to give a balanced effect with maximum legibility.

The first stage in the actual drawing is the plotting of triangles or other lines which are the basis of the survey. Lines should be light and carefully ruled to be perfectly straight. A fairly hard pencil, H or HH, is best, sharpened to a fine round point. Much of the setting-out will be on a geometrical basis, using methods described in Chapter II. Instruments, including ordinary and beam compasses, must be used with accuracy or serious mistakes difficult to locate may occur. It is as well to indicate station points by small circles and letters as the work proceeds.

When the framework is complete, details can be filled in, generally by rectangular offsets. It is here that the use of the closely-divided surveying scale with its similarly divided offset scale facilitates the work, the main scale being held in position by weights along each of the lines of the framework in turn, so that the offset scale can be moved against it and the positions and distances of the offsets can be marked off by means of pencil dots or, probably better, by a small pricker. If the special scales are not available, the edge of a T-square or straight-edge can be placed along the framework lines, on which the positions of the offsets have been marked, and then by sliding a right-angled set-square along the T-square or straight-edge the offset lines can be lightly drawn in and their lengths carefully measured and marked off (see Fig. 44). It then only remains to draw in the hedges, fences, buildings, etc., using a set-square for straight lines and french curves, or freehand, for the others.

The drawing can be finished by strengthening the pencil lines where necessary, or by inking in. The survey, that is the

setting-up, lines are usually erased unless subsequent additions are likely to be made.

All drawings should be neatly titled in suitable lettering, usually placed at the bottom of the sheet, although it can be put wherever seems appropriate. A north-point should always be shown prominently; it should show directions of both true and magnetic north—a straightforward type is shown in Fig. 73. Drawings should be signed or name-stamped with the date in the bottom right-hand corner. The scale should be drawn as well as written. Contour lines or spot levels may have to be shown, the former should be indicated by broken lines, alternate dots and dashes, or by continuous lines in sepia or other distinguishing colour, with the contour heights figured by the side neatly and regularly. Levels reduced to Ordnance Datum should be marked "O.D.".

Various conventional signs and symbols are more or less standardised for survey drawings. Fig. 73 shows some of the most common ones. The "T" on the lines for hedge or fence indicate ownership; "T's" on both sides indicate common ownership. Buildings to a comparatively large scale, unless coloured, are shown with diagonal hatching; to a small scale they are shown solid black.

Colouring is less used at the present time for these drawings. There appears to be no standard practice. Amongst colours commonly used are:

Buildings	— light crimson lake or neutral tint (the former for new buildings, the latter for existing if both appear together). Public buildings, etc., often receive special treatment, e.g. hatching or solid black.
Water	— Prussian blue, darkest at the edge, rapidly graded off to the middle of lakes and rivers.
Arable land	— sepia or burnt umber.
Pasture	— light green; adjoining fields varied in tone.
Trees, Hedges	— darker green.
Roads	— light burnt sienna or sepia.
Footpaths	— darker tone of above.

Boundaries of different properties are shown when necessary by edgings of different colours. If there is one estate only the edging is usually crimson lake; if two only, crimson lake and some suitable green; if more than two, crimson lake, green, blue, yellow, brown, neutral tint are used. A reference schedule with the colours shown in small rectangles with the names of the owners adjoining, can be added at the side of the drawing.

Conveyance and Lease Plans

Drawings are used to assist in the identification of land or

property in connection with sales and leases. The drawings are usually attached to and form part of the legal documents.

Boundaries should be clearly and accurately shown. In the case of building plots the frontages, depths and widths at the rear should be dimensioned in feet and inches. As individual plots are usually traced from a survey plan of the estate it is essential that the latter is correct in all respects and that the tracing is carefully made. Where natural boundaries do not exist, tie-measurements to the nearest road should be shown and dimensioned. Ownership of and responsibility for the maintenance of fences, etc., is indicated by "T" marks, see Fig. 73. Double "T's" indicate shared responsibility.

Colours are used to show the land conveyed, usually crimson lake or burnt sienna, and any part over which a right-of-way is granted, usually blue.

Descriptive lettering should be neat and legible. North-points must always be shown, as reference to cardinal points is frequently made in the wording of the documents. Both true and magnetic points with date should be shown, but generally the former only is sufficient. If measurements are fully shown a drawn scale is not necessary.

Auction Sale Plans

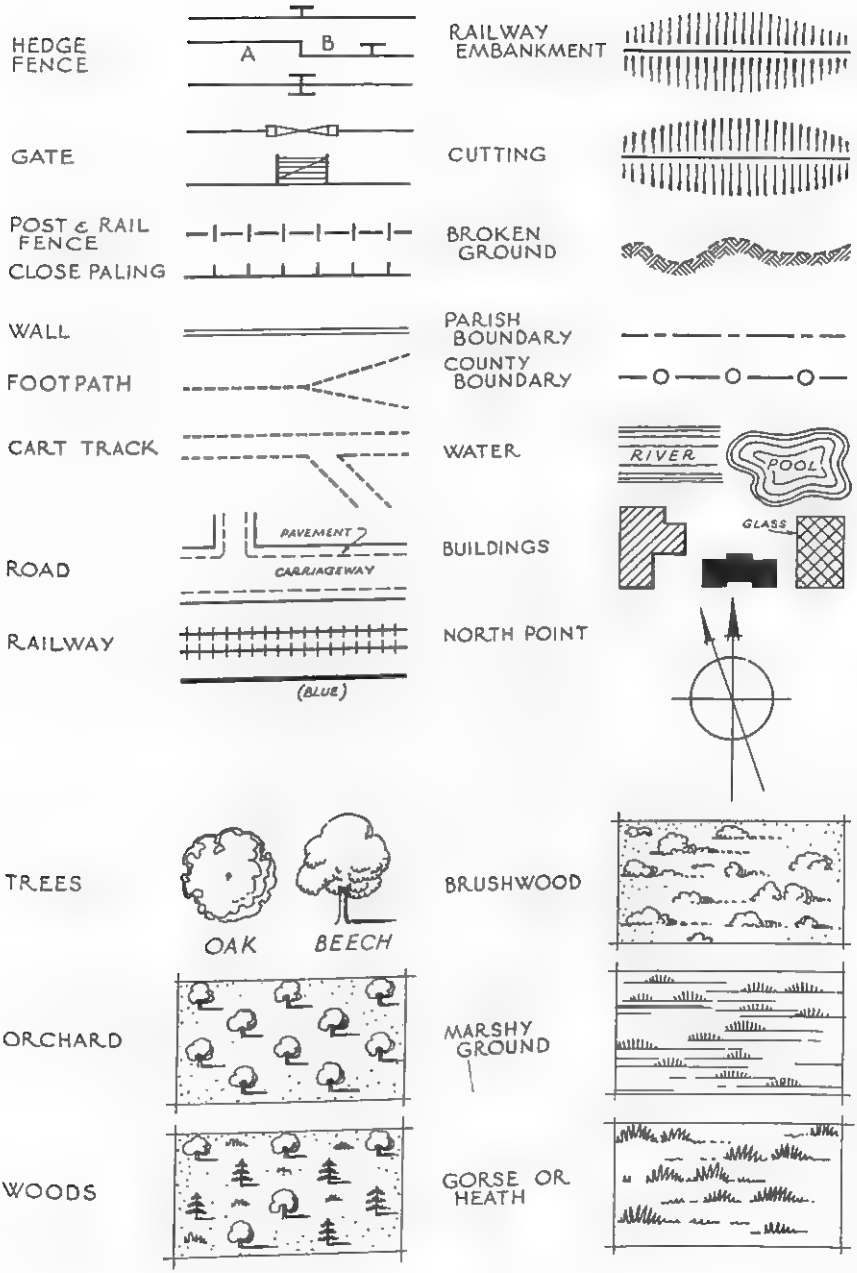
These are similar to conveyance plans. They must show the position, extent and shape of the property. Different approaches should be clearly marked "To . . ." or "From . . .". Names of neighbouring owners, estates and premises, etc., which will help determine the position, should be included. It is sometimes desirable to show an inset key plan to a small scale showing the area surrounding the site, with principal roads, railway stations, bus routes, etc., indicated.

The plans are frequently reproduced or traced from Ordnance Survey maps. 25″ scale is usually sufficient for land, but 1/500 scale is often used for urban districts.

It is not essential that such plans should be extremely accurate and any misunderstanding in this connection can be avoided by a note added to the drawing as follows: "This plan is for identification purposes only and although believed to be correct is not guaranteed and shall not be deemed part of any contract."

A north-point is essential and a scale should be drawn as well as stated. It may also be necessary to show dimension lines and figured dimensions for frontages and depths, positions of building lines, if existing, approximate positions and directions of flows of any sewers, and the positions and kinds of any trees.

Lettering should be placed where it can be easily read and, so far as possible, should "read" in one direction.



CONVENTIONAL INDICATIONS FOR SURVEY DRAWINGS

Fig. 73

Architectural Drawings

The range of architectural drawings is considerable and includes widely differing techniques. The following is a general classification of the main types:

(1) *Preliminary Sketch Designs*—Drawings made in the process of working out the main lines of a design; includes more or less freehand sketches as well as roughly set-up plans, elevations and sections to a small scale. The purpose of a sketch design is to arrive at a solution of major problems only, and should therefore be tentative in character. Nevertheless, for purposes of discussion between architect and client, they can be attractively presented with shadows and surroundings sketchily suggested.

Sketch designs which are part of architectural training are of a somewhat similar nature to the above but, as well as planning exercises, they include a large proportion of design problems of a more imaginative kind, calling for the rapid and effective presentation of solutions usually in perspective. Usually not more than six hours are allowed for the preparation of such drawings and the presentation must therefore be on broad lines without overmuch attention to detail, the suggestion of the essential qualities of the design, construction and general character being all that is required. Freedom of technique is imperative and the opportunities should be taken for experiments in appropriate media, such as soft pencil, crayon, charcoal, pastel, poster colour, etc., and in the using of various papers, including coloured and textured papers.

(2) *Design or Presentation Drawings*—Finished design drawings show a minimum of constructional detail, although the construction must be fully worked out before they can be properly completed. In practice it often happens that after agreement has been reached on a preliminary sketch design, the next step is the preparation of working drawings with such modifications as may be necessary, and finished design drawings are not made until later, if at all. The designs of students, however, are usually required to be shown fully on well-finished presentation drawings.

In all cases the drawings may be orthographic projections, metric projections, or perspectives accurately drawn and effectively rendered, generally on Whatman or similar quality paper. The lay-out of the sheets is important; and care must be taken to avoid crowded and unbalanced arrangements. Dimensions should not normally be shown, nor should notes of materials—except as footnotes—nor structural details on plan and section unless required for some special purpose.

Conventional shadows should be shown (see p. 163) in order to explain the forms, etc., and appropriate surroundings can be included. The degree of formality or freedom of the presentation will depend upon the character of the subject and the use to which the drawing will be put. Lettering in particular must be carefully arranged and executed in a suitable alphabet. It will be confined in the main to the title, labelling of plans, elevations and sections, names of rooms, etc., and possibly some brief general notes.

Colour design drawings are usually orthographic or axonometric projections of the interiors of rooms and serve both to show the design and to guide the execution of the actual work. Colours should therefore be as near as possible to those to be used. Flat opaque hues should be used for painted areas. Designers' colours, poster colours or ordinary water colours added to a base of Chinese white is the medium to adopt. Other materials should be naturally represented.

(3) *Working Drawings*—These are the drawings from which the building work is actually carried out. They must therefore give all the graphical information necessary for constructional purposes, and must be accurately drawn. They include orthographic projections of all plans, elevations and essential sections, orthographic and metric details at various scales and workshop drawings.

Conventional methods of preparing working drawings and of indicating thereon details and materials are now generally accepted, and are dealt with in Chapter V.

Working drawings are usually prepared first in pencil on cartridge paper and then traced in ink for photo-print copies, see Chapter VI. No shadows or shading other than the indication of materials, and no extraneous details not relevant to the construction should be shown. A "busy" working drawing in which every detail is drawn elaborately and repeated unnecessarily has no advantages and may be illegible. Lettering must be clear and tidily arranged, particularly as it may constitute half the drawing. Nevertheless, it must be kept as brief as possible and any general notes should not be expanded to long clauses belonging properly to the specification.

(4) *Measured Drawings*—These scale drawings are made from carefully taken measurements of existing buildings of historic interest and architectural merit as part of students' training in design and also, to an increasing extent, for purposes of recording such works.[1] The drawings may illustrate a whole building or part of a building and may range from small-scale plans and

[1] *The National Buildings Record*, the chief body concerned with the recording of buildings of interest in this country, makes considerable use of measured drawings.

elevations to full-size details. Space here does not allow a full description of the various types of subject and their presentation. Sometimes, form or decoration is the chief interest; in other cases constructional features are of most importance. Technique must vary accordingly, but elaborate rendering is generally unnecessary. The more direct the exposition the better, with special care being taken in regard to freehand detail, titles and lettering. Accuracy is, of course, a first essential, and the quality of the draughtsmanship should be of the highest. Drawings mainly in pencil with outlines of plans and sections in ink and perhaps with openings and conventional shadows in wash are usually satisfactory. Part plans and sections are often superimposed over corresponding details shown in elevation. The scale and north-point should always be shown prominently and descriptive notes should be well arranged.

In making the survey of a building, the first step is to make a series of diagrammatic sketches (see Chapter IX) on which the necessary measurements can be marked. The importance of these sketches cannot be over-emphasised. They should be made in suitable stiff-backed sketch-books of thin but tough plain paper, preferably not less than $15'' \times 10''$ in size. Complicated work is best plotted to a small scale as the measuring proceeds. A half- or quarter-imperial board can be used and is light enough to be carried to the job.

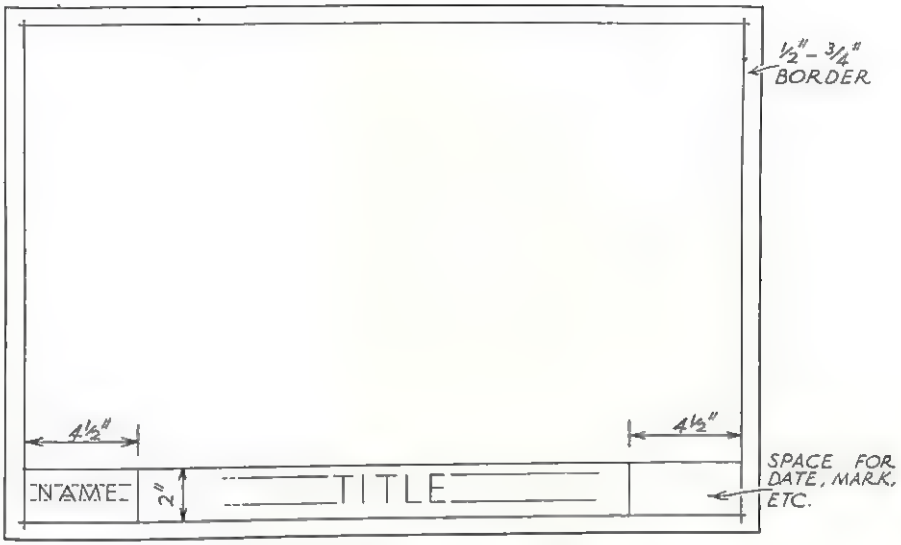
Sketch measured drawings are carefully made sketches, often in perspective and sometimes with approximate scale details added, on which overall main measurements are shown by lines and arrows.

General Lay-out of Drawings

These notes apply to all types of drawings, but are made with special reference to architectural drawings.

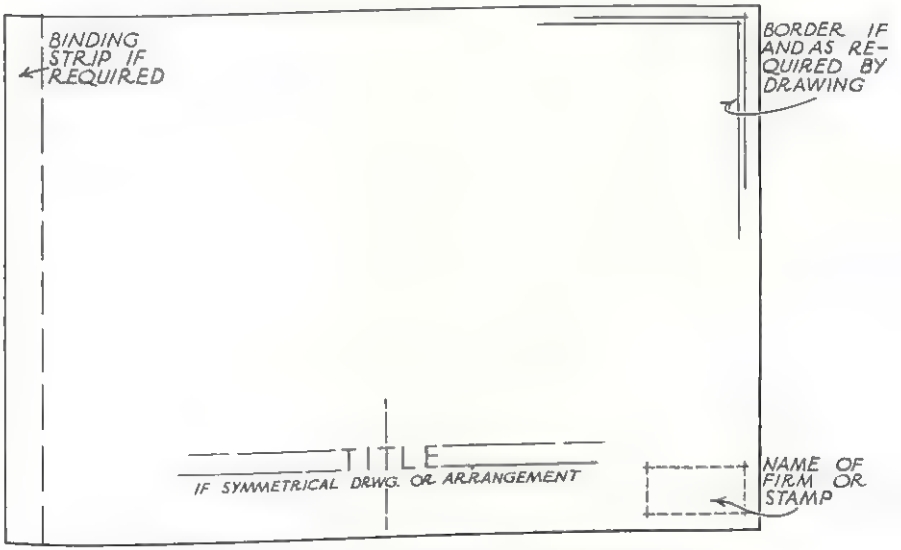
Sizes of working drawings and site plans should conform to the standard dimensions referred to previously, p. 80, but architectural design drawings and students' exercise drawings need not necessarily be standardised. Fig. 74 shows a suitable lay-out for the last-named providing spaces for title, student's name, and date, mark, etc. Some such lay-out is advisable for early geometry, construction and similar sheets.

Fig. 75 shows the lay-out of design drawings. Titles are usually best placed towards the bottom of the sheet and should be symmetrically disposed if the arrangement as a whole is otherwise symmetrical, but the title must always be included as part of the composition of the drawing, and it may therefore be advisable to place the title in some other position. The title must never be "mean" or out of keeping with the character of



GENERAL LAY-OUT OF STUDENT'S EXERCISE DRAWING NORMAL DRAWING PAPER SIZES.

Fig. 74



GENERAL LAY-OUT OF DESIGN DRAWINGS

NORMAL DRAWING PAPER SIZES UNLESS TO BE BOUND WITH WORKING DRAWINGS.

Fig. 75

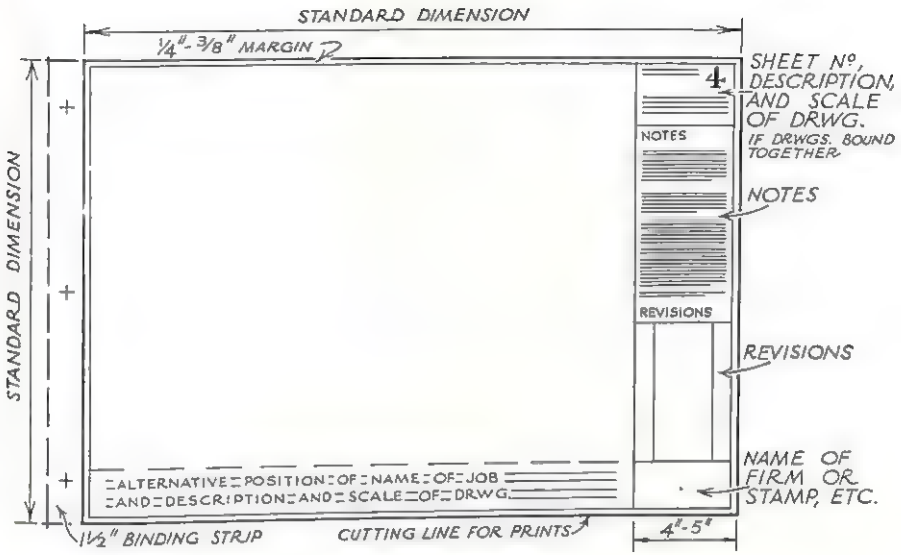
the subject. The name of the designer(s) and draughtsman should appear in the bottom right-hand corner unless forming part of the title. Borders should be simple and neatly drawn, consisting of two or three ruled lines with perhaps a band of colour. They are helpful in pulling together a loosely composed sheet, but are not essential, and are undesirable if the drawing is made on untrimmed hand-made paper which has a deckle edge.

Fig. 76 shows a type of lay-out for contract and working drawings which is becoming standard practice. Such a standard arrangement makes easier the reading of drawings, makes it possible for essential references to be located without trouble—an important point when drawings are prepared in several offices for one job, and reduces the likelihood of essential information being omitted. The placing of general and revision notes in a panel immediately above the name-panel makes them readily seen if the drawings or prints are bound together or folded, as suggested on p. 20.

Fig. 77 shows a detail of a revision panel and name block, which may be drawn or stamped.

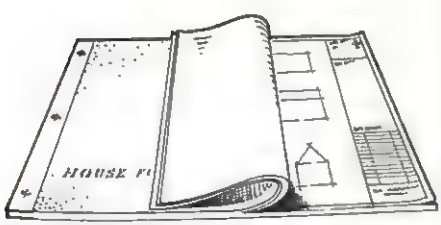
Titles of jobs and descriptions of drawings should be as brief as possible. The title should not be varied on different drawings relating to the same work, nor during the progress of the contract. If the drawings or prints are to be bound together, as shown in Fig. 78, it is probably better to have the title and sheet number in the top right-hand corner; if the sheets are to be kept loose in the drawers of a plan chest, the title, etc., is more readily seen if put along the bottom.

Fig. 79 shows the arrangement of a typical $\frac{1}{8}''$ scale working drawing of a small house on a standard sheet laid out as shown in Fig. 76. Further details of the plans, elevation, sections, etc., are given in Figs. 105–108.



GENERAL LAY-OUT OF WORKING DRAWINGS

Fig. 76



SET OF BOUND DRAWINGS

Fig. 78

REVISIONS

DATE:	DESCRIPTION:	INITIAL:

NAME OF FIRM

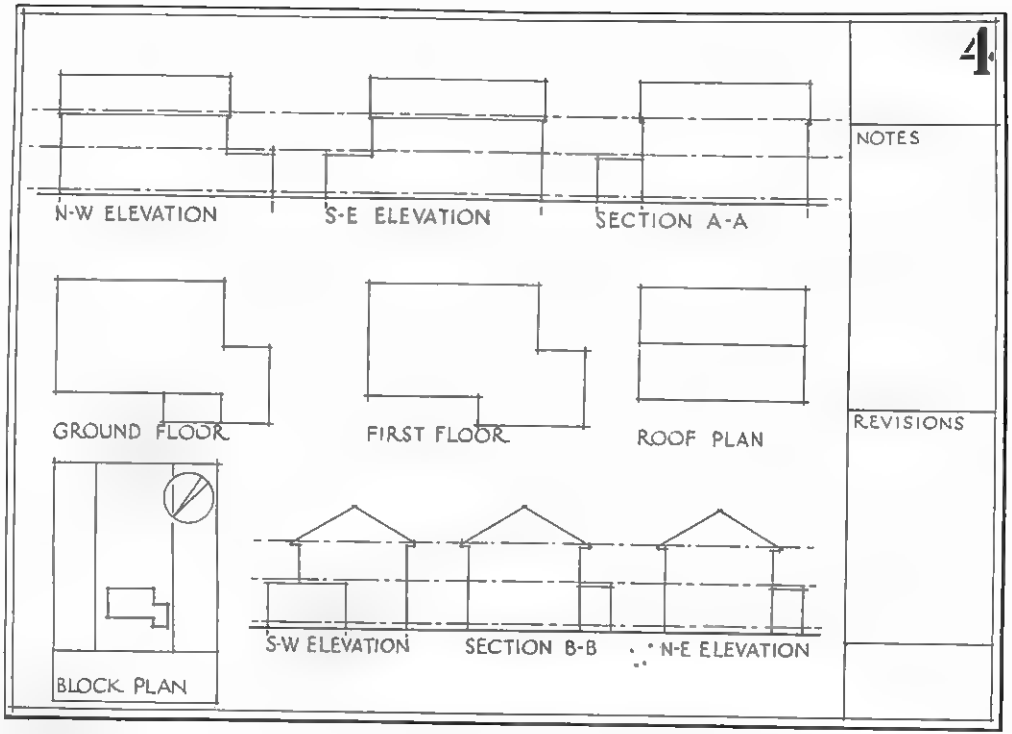
DESCRIPTION

ADDRESS AND TELEPHONE Nº

DRWG.Nº	DRWN BY	TRACED	CHECKED	APPROV'D

DETAIL OF REVISION COLUMN AND NAME BLOCK

Fig. 77



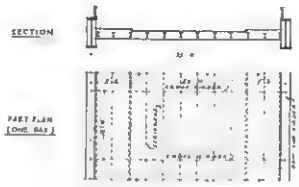
LAY-OUT OF DRAWING TYPICAL 1/8" SCALE WORKING DRAWING OF SMALL HOUSE

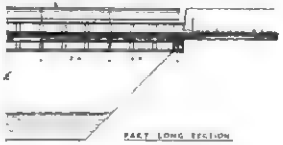
Fig. 79

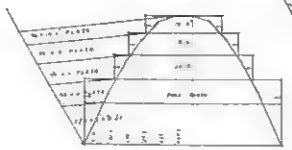
GROUND FLOOR

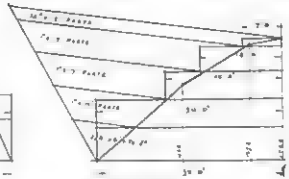
THE MANOR HOUSE HOSPITAL GOLDERS GREEN LONDON

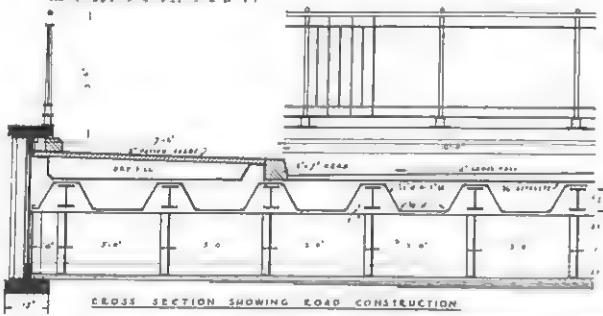
DESIGN FOR ROAD BRIDGE - 60'-0" SPAN.

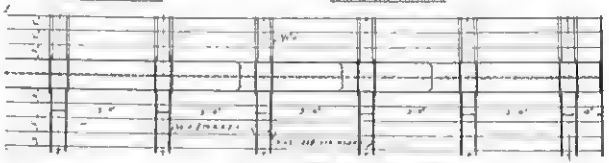


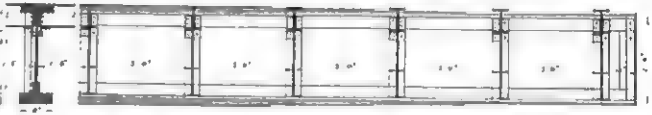


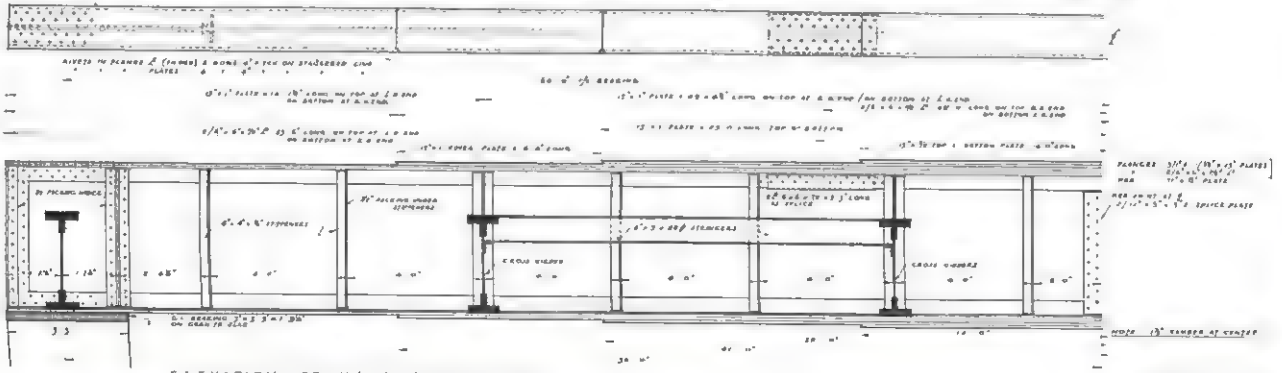












CHAPTER V

CONVENTIONAL INDICATIONS AND REPRESENTATION ON DRAWINGS

THE following notes deal with various conventional methods of indicating details and representing materials on architectural drawings, with particular reference to working drawings.

Indication of Dimensions

Reference has previously been made to the drawing of dimension lines. Fig. 80 shows portions of the plan, elevation and section of a building of solid construction, and illustrates how the dimension lines are arranged. Horizontal dimensions are shown on plan so far as possible. Generally, two lines are necessary running parallel to and a short distance away from the outside walls. From every "break" or change of direction of the wall, and every "rough" opening in it short perpendicular lines are taken to cut the inner dimension lines, and the dimensions of each horizontal part of the wall can then be figured between them. The outer dimension lines are used for the over-all lengths of walls and are terminated by lines brought out at the ends of the building. Where the wall is long and divided up by pronounced breaks, these lengths may be indicated in addition to the over-all length. Care must be taken that there is agreement between the inner and outer dimensions.

Dimension lines are also drawn inside the enclosing walls of the building a short distance from the inner faces. They are extended to cut the enclosing walls at right-angles, and are dimensioned to show thicknesses of walls and partitions as well as lengths and widths of rooms between unfinished wall surfaces. It is usually impossible to put the dimension figures for wall thickness within the outlines of the walls, and they should therefore be put a little to one side with a link line to show to what they refer. Where it is necessary to show the height of a room on plan, the dimension should be enclosed in a circle.

Vertical dimensions are shown on section. Two vertical lines are drawn a little away from the outside walls, the inner one to show positions of openings in relation to floor levels and the outer one to show floor to floor heights. Sometimes a dimension line is put inside the building to show floor to ceiling heights or floor to inside cill heights, but generally this is not necessary. Over-all heights except where they have special meaning are also unnecessary. Heights should not be taken from ground

level, which is of course variable, but from some datum, usually a suitable point on the ground-floor level, although the required level of outside paving can be shown.

Horizontal broken lines should be drawn across elevations and sections at the various floor levels (see Fig. 80), and should be lettered: "Basement", "Ground Foor", "First Floor", and so on. The floor levels can be shown in feet and inches at the ends of these lines in relation to the datum, those above the datum being prefixed by a + sign, and those below by a — sign. The figures should be enclosed in semi-circles terminating in arrow-heads at the level lines. Sometimes the levels are expressed as feet and decimals of feet above ordnance datum, but generally this aspect is covered by a note relating the datum of the building to some near-by ordnance bench mark. Where it is considered necessary to indicate datum levels on plan they are prefixed with either the + or — sign as the case may be and enclosed within a circle sometimes in colour.

In addition to the main dimension lines referred to above, other dimension lines may be necessary in order that the position of no part of the building is in doubt. All dimensions necessary for the carrying out of the work must be given. It should not be necessary to scale a drawing for this purpose other than a full-size detail. Dimensions which are not to scale, however, should be indicated by the addition of the letters "N.T.S.".

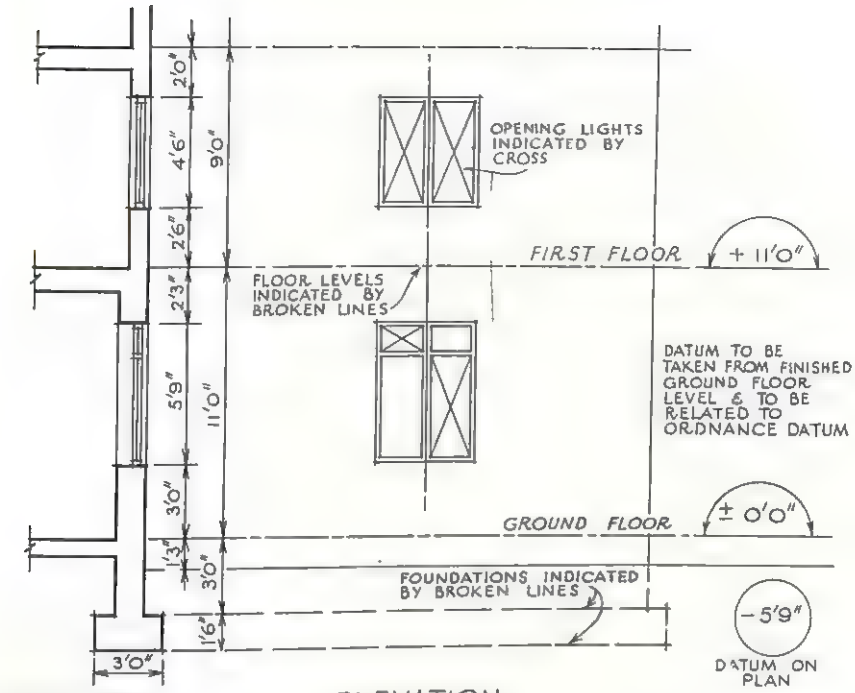
Where the structure is framed, dimensions should be related to the column or stanchion centres, as shown in Fig. 81. This usually necessitates three outside dimension lines; the innermost one for "breaks" and openings and stanchion centres, the middle one for stanchion centres only, and the outermost one for over-all measurements.

Numbering of Plan Units

The following is the recommendation of the British Standards Institution regarding the numbering of plan units in general:

All rooms or enclosed spaces of any description, windows, doors, radiators, etc., should be numbered consecutively on plan. Numbers should commence at the top left-hand of the plan and proceed from left to right in regular sequence, finishing at the bottom right-hand. Numbers should be appropriately prefixed, as shown below:

	Rooms	*Windows*	*Doors*	*Radiators, etc.*
Sub-basement	SB01 etc.	WSB01 etc.	DSB01 etc.	RSB01 etc.
Basement	B01 etc.	WB01 etc.	DB01 etc.	RB01 etc.
Ground Floor	G01 etc.	WG01 etc.	DG01 etc.	RG01 etc.
First Floor	101 etc.	W101 etc.	D101 etc.	R101 etc.
Second Floor	201 etc.	W201 etc.	D201 etc.	R201 etc.


2'0"
4'6"
9'0"
2'6"
2'3"
5'9"
11'0"
3'0"
1'3"
3'0"
1'6"
3'0"
OPENING LIGHTS INDICATED BY CROSS
FIRST FLOOR
+ 11'0"
FLOOR LEVELS INDICATED BY BROKEN LINES
DATUM TO BE TAKEN FROM FINISHED GROUND FLOOR LEVEL & TO BE RELATED TO ORDNANCE DATUM
GROUND FLOOR
± 0'0"
FOUNDATIONS INDICATED BY BROKEN LINES
-5'9"
DATUM ON PLAN
SECTION
ELEVATION

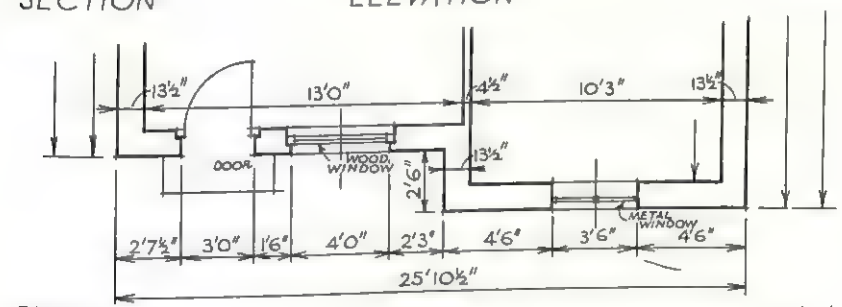

13½"
13'0"
4½"
10'3"
13½"
DOOR
WOOD WINDOW
13½"
2'6"
METAL WINDOW
2'7½"
3'0"
1'6"
4'0"
2'3"
4'6"
3'6"
4'6"
25'10½"
PLAN

Fig. 80

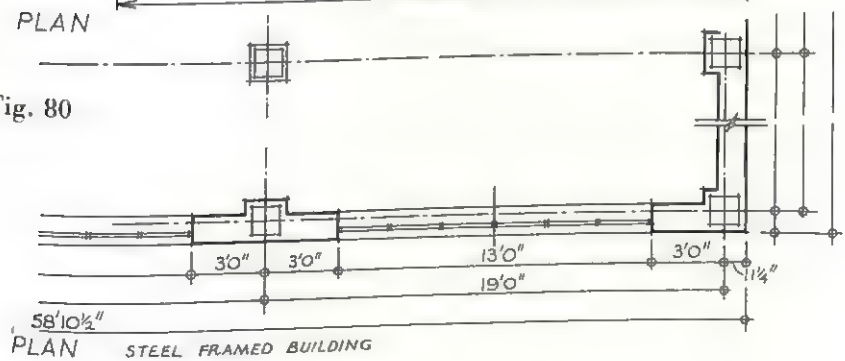

3'0"
3'0"
13'0"
3'0"
19'0"
11¼"
58'10½"
PLAN
STEEL FRAMED BUILDING

Fig. 81

Representation of Materials

Fig. 82 shows the conventional line indications of materials in general use.[1] All diagonal lines are at 45 degrees. The spacing of the lines should be varied, of course, according to the scale of the drawing, but the general proportions shown here should be adhered to. A common error is to space the hatching for brickwork either too widely apart or too close together. Modifications according to the scale are suggested in regard to certain indications. Where large areas of hatching need to be indicated, and especially for such materials as plaster and concrete, only a portion near the edge or ends should be shown, the hatching gradually "fading" towards the middle, as shown in the examples.

The elevational indications are for materials which are otherwise difficult to distinguish. The indication for glass should not be used for windows.

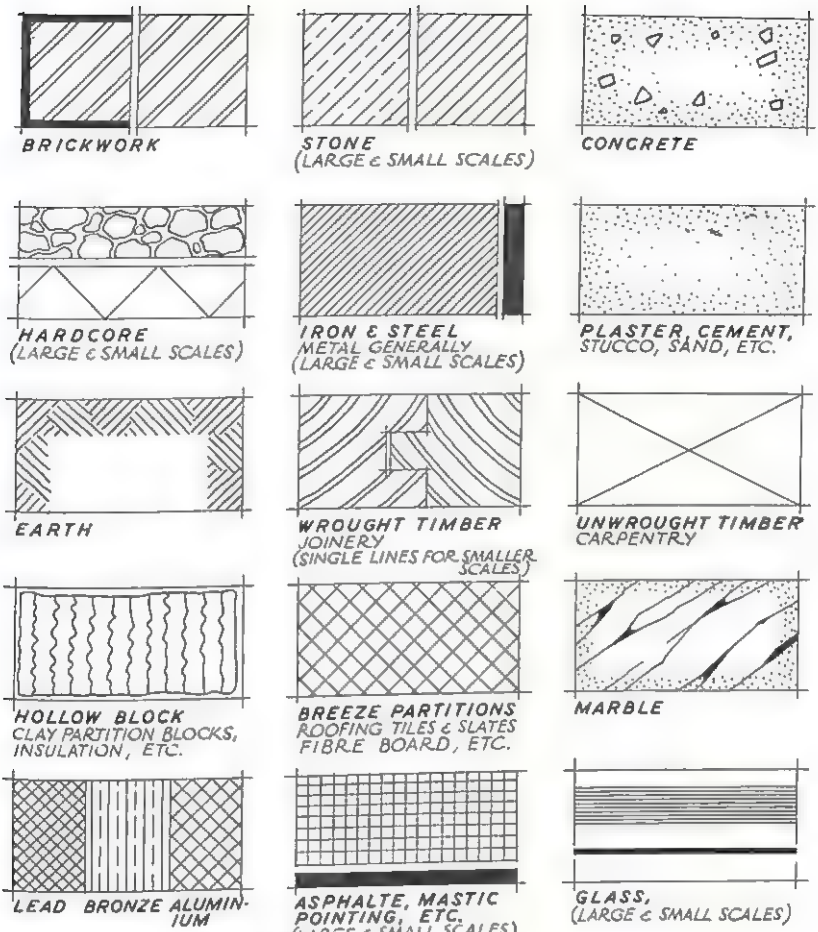
Where confusion is likely to occur in the interpretation of the indications a legend or key should be added to the drawing.

Indication of materials by colour is less used at the present time, although sometimes asked for by Local Authorities, and some quantity surveyors prefer to work from coloured drawings. The following is a list prepared by the British Standards Institution and recommended for standard practice. There are, however, many variations in different parts of the country.

Material	*Colour*	*Material*	*Colour*
Brick	Vermilion	Cast Iron	Paynes Grey
Concrete	Hooker's Green No. 1	Wrought Iron	Prussian Blue
Earth	Sepia	Granite, Marble, other natural stones	Cobalt Blue
Hardcore or Dry Fill	Chrome Yellow Medium	Steel	Purple
Plaster	Terra Verte	Cast or Reconstructed Stone	Viridian
Special Plaster, Acoustic, Fibrous, etc.	Mauve	Unwrought Timber	Raw Sienna
Asbestos Cement	Neutral Tint	Wrought Timber	Burnt Sienna (Vandyke Brown for hardwood if to be distinguished from softwood)
Faience, Tiles, etc.	Chrome Orange		
Cement Screed	Payne's Grey	Glass	Pale Blue wash

Other materials at the discretion of the draughtsman.

[1] The indication of brickwork by double lines differs from that recommended by the British Standards Institution, which suggests single line diagonal hatching. Double line is, however, widely used and, in the author's opinion, is less likely to be confused with other indications.



CONVENTIONAL INDICATION OF MATERIALS

Fig. 82

For elevations, colouring should be in lighter washes of the above for working drawings, but reasonable liberties are permissible to avoid a garish effect so long as misinterpretations are not likely to arise.

Colours and coloured lines should not, of course, be used on tracings or drawings from which photo-print reproductions may be required.

Abbreviations

The following list of abbreviations of words commonly used on drawings is taken from the B.S.I. standards for Architecture and Building Drawing Office Practice:

Primary Units

Centimetre	cm.	Ounce	oz.
Chain	ch.	Pound	lb.
Cubic foot	cu. ft.	Quarter	qr.
Cubic yard	cu. yd.	Square inch	sq. in.
Dozen	doz.	Square foot	sq. ft.
Foot	ft, or (′)	Square yard	sq. yd.
Hundredweight	cwt.	Ton	t.
Inch	in. or (″)	Yard	yd.
Metre	m.		
Millimetre	mm.		

Materials and General Terms

Aggregate	agg.	Invert	inv.
Air brick	A.B.	Lavatory basin	L.B.
Approved	appd.	Left hand	L.H.
Approximate	approx.	Macadam	mac.
Asbestos	asb.	Manhole	M.H.
Asphalt	asph.	Mild Steel	M.S.
Bench mark	B.M.	Not to scale	N.T.S.
Birmingham gauge	B.G.	Number	No.
Bitumen	bitn.	Petrol interceptor	P.I.
Brickwork	bwk. or B.	Radius	rad.
British Standard	B.S.	Rain-water pipe	R.W.P.
Cast iron	C.I.	Reinforced concrete	R.C.
Cement	cem.	Right hand	R.H.
Centre line	C.L. or C.	Rising main	R.M.
Centre to centre	c/c.	Rain-water outlet	R.W.O.
Checked	ckd.	Round	rd.
Chemical closet	C.C.	Sink waste	S.W.
Clearing eye	C.E.	Sink	S.
Concrete	conc.	Sketch	sk.
Corrugated	corr.	Sluice or stop valve	S.V.
Diameter	dia.	Soil and vent pipe	S. & V.P.
Drawing	drg.	Soil pipe	S.P.
Drinking fountain	D.F.	Specification	spec.
Earth closet	E.C.	Spigot and socket	S. & S.
Figure	Fig.	Square	sq.
Fire hydrant	F.H.	Standard Wire Gauge (Imp.)	S.W.G.
Flushing cistern	F.C.		

Fresh air inlet	F.A.I.	Stand pipe	St. P.
Galvanised	galv.	Street gully	S.G.
Glazed-ware pipe	G.W.P.	Tongued and grooved	t. & g.
Grease trap	G.T.	Traced	Tcd.
Ground level	G.L.	Urinal	U.
Gully	G.	Vent pipe	V.P.
Height	ht.	Volume	Vol.
Hose bib	H.B.	Waste pipe	W.P.
Inspection chamber	I.C.	Waste and vent pipe	W. & V.P.
Insulated or insulation	insul.	Water closet	W.C.
Intercepting trap	I.T.	Weight	Wt.
Internal	int.	Yard gully	Y.G.

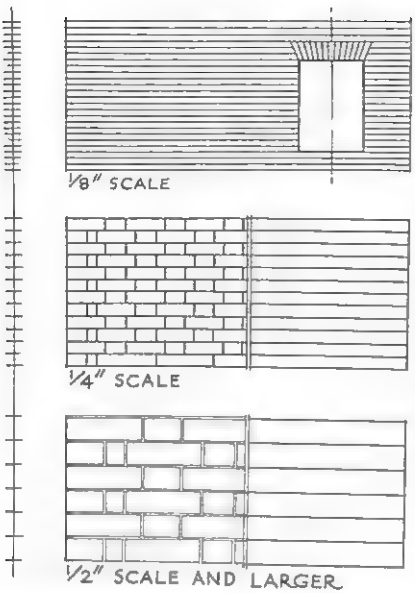
Drawing and Indication of Constructional Materials

(1) *Brickwork.*—On plan and section indicated by solid black at small scales and by conventional hatching at $\frac{1}{8}''$ scale and upwards (although some consider $\frac{1}{8}''$ scale too small for hatching). On detail drawings the horizontal course lines are sometimes shown in addition to or instead of hatching on section, especially where there is some particular relevance to the construction. Difficulties occur with hatching on curved walls on plan, but there seems to be no solution to the problem, nor to the optical illusions which the diagonal lines of the hatching tend to produce. The worst effects, however, can be avoided by carefully considering the placing of the lines.

Fig. 83 shows the indication of brickwork on elevation at various scales. It is better to set out the heights of the courses on a vertical line at the left-hand side of the sheet and to rule across from this with the T-square than to set out the courses actually on the elevation, where the markings tend to become confused and are difficult to rub out. The courses can also be numbered and provide a means of checking other settings-out.

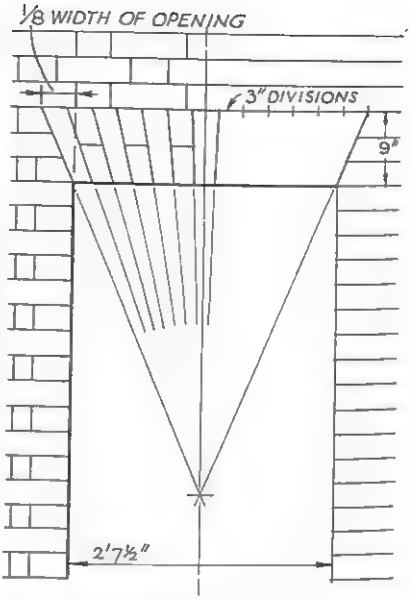
The courses are not usually shown at less than $\frac{1}{8}''$ scale, except in pencil on some careful design drawings. At $\frac{1}{8}''$ scale single lines are shown, individual bricks being indicated only for flat arches and similar features. At $\frac{1}{4}''$ scale vertical joints can be indicated also if necessary, but are not essential. At $\frac{1}{2}''$ scale and larger it is possible to show double lines to indicate the thicknesses of joints. In general, joint lines should be thinner than outlines whether in ink or pencil. They should extend over the whole area of the material or be confined to regular areas which will be sufficient to convey the required impression. The indication should not be spotted about the elevation, so camouflaging it and making it look in bad repair.

Figs. 84, 85 and 86 show typical methods of setting out flat and segmental gauged arches and segmental rough arch in brickwork. 3″ bricks, including joint, have been assumed, and



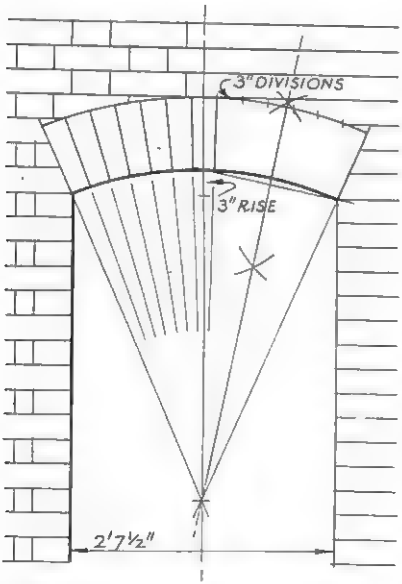
BRICKWORK IN ELEVATION

Fig. 83



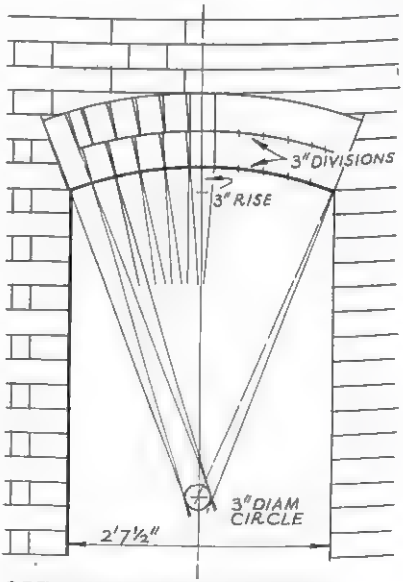
SETTING OUT OF FLAT GAUGED "ARCH"

Fig. 84



SETTING OUT OF GAUGED BRICK ARCH

Fig. 85



SETTING OUT OF ROUGH BRICK ARCH

Fig. 86

the marking-out of the positions of the bricks and the finding of centres can be seen from the drawings which are reproduced at $\frac{1}{2}''$ scale.

(2) *Masonry.*—Stone walls are indicated on plan and section solid black under $\frac{1}{8}''$ scale and sometimes at $\frac{1}{8}''$ scale, otherwise by conventional hatching. The courses are shown to the larger scales on section, and sometimes the individual stones are shown on plan, e.g. when the facing differs from the backing.

Rubble walling is shown on plan and section as more or less irregular stones either in black with white joints or in outline. Fig. 87 shows plans and sections of three types of rubble walling at $\frac{1}{2}''$ scale and the methods of drawing the corresponding elevations. It is important with masonry indication of this kind that the size, shape and arrangement of the stones are reasonably like the actual construction. Haphazard scribble will not do to indicate rubble, nor will careful drawing if long vertical joints occur and the stones at angles and openings are impossible in practice.

Fig. 88 shows part elevation of an ashlar masonry wall. Here the joints are or should be an integral part of the design and must be accurately shown. If the drawing is to give full information to the masons, the dimensions of every stone must be apparent and the stones may have to be numbered. The heights of the courses are usually taken from bed to bed of the joints and are shown on a vertical dimension line. Horizontal dimensions are shown on horizontal dimension lines passing through typical courses. Some additional dimension lines may be necessary around openings or similar features where the arrangement of the stones is varied. Openings must be dimensioned. Plans and sections give the third dimensions of the stones.

Stones are crossed—diagonal lines from corner to corner—on elevation where otherwise their shape and size might not be clear owing to dimension or other lines. It is generally unnecessary to cross every stone.

There seem to be various methods of numbering the stones, but the logical system is to follow more or less the sequence in which they are laid. Each course is indexed by letters referring to the approximate orientation of the elevation on which it occurs and its position in relation to other courses. In the example illustrated the distinguishing letters are: "S" for south elevation and A, B, C, etc., for the sequence of courses starting at the bottom. If the alphabet becomes exhausted, then it begins again doubled, AA, BB, CC, although some abbreviation is necessary if the building is of considerable height. The stones take the indexing of their course and are numbered from left to right. Note that where there is a return elevation the stones

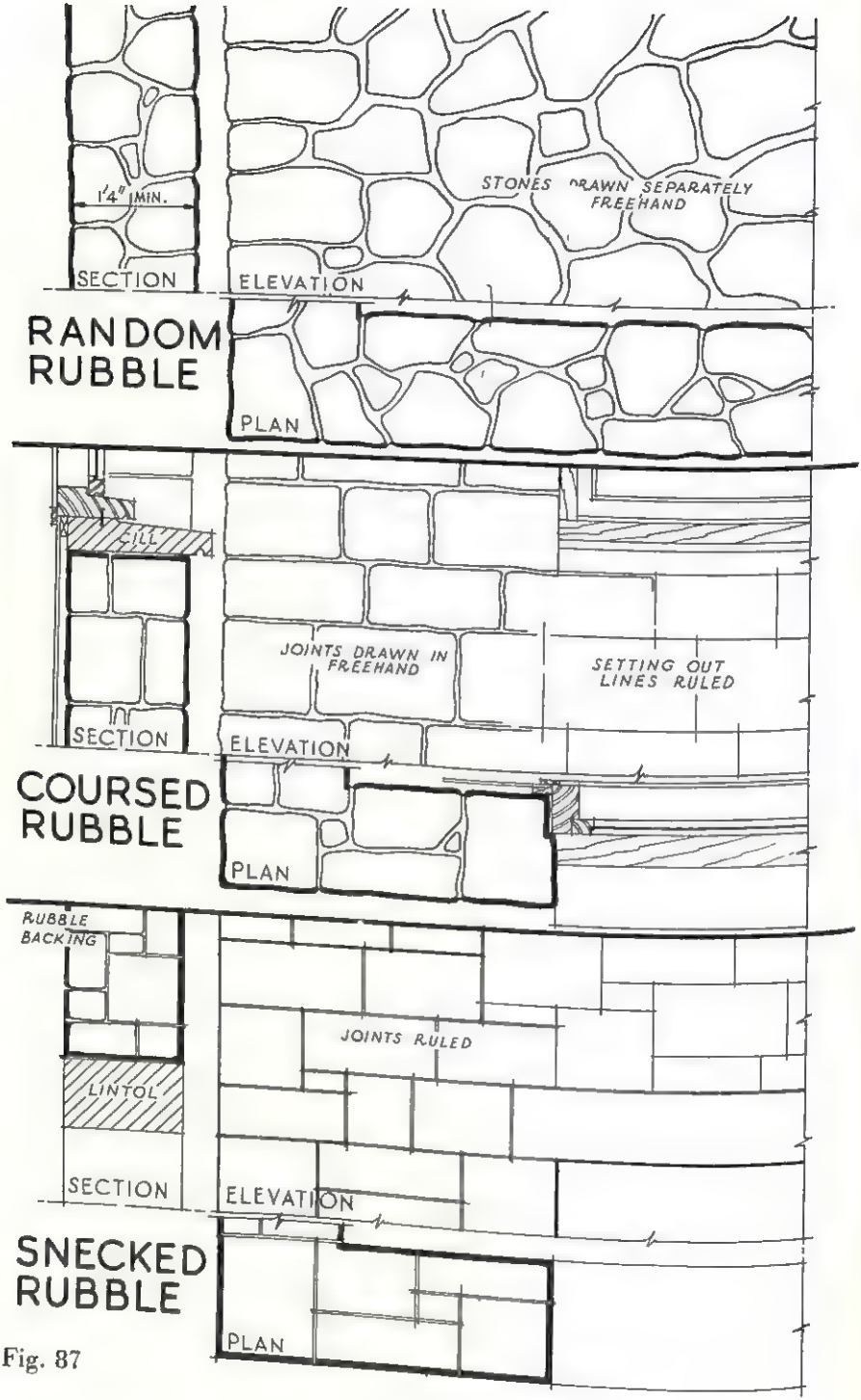
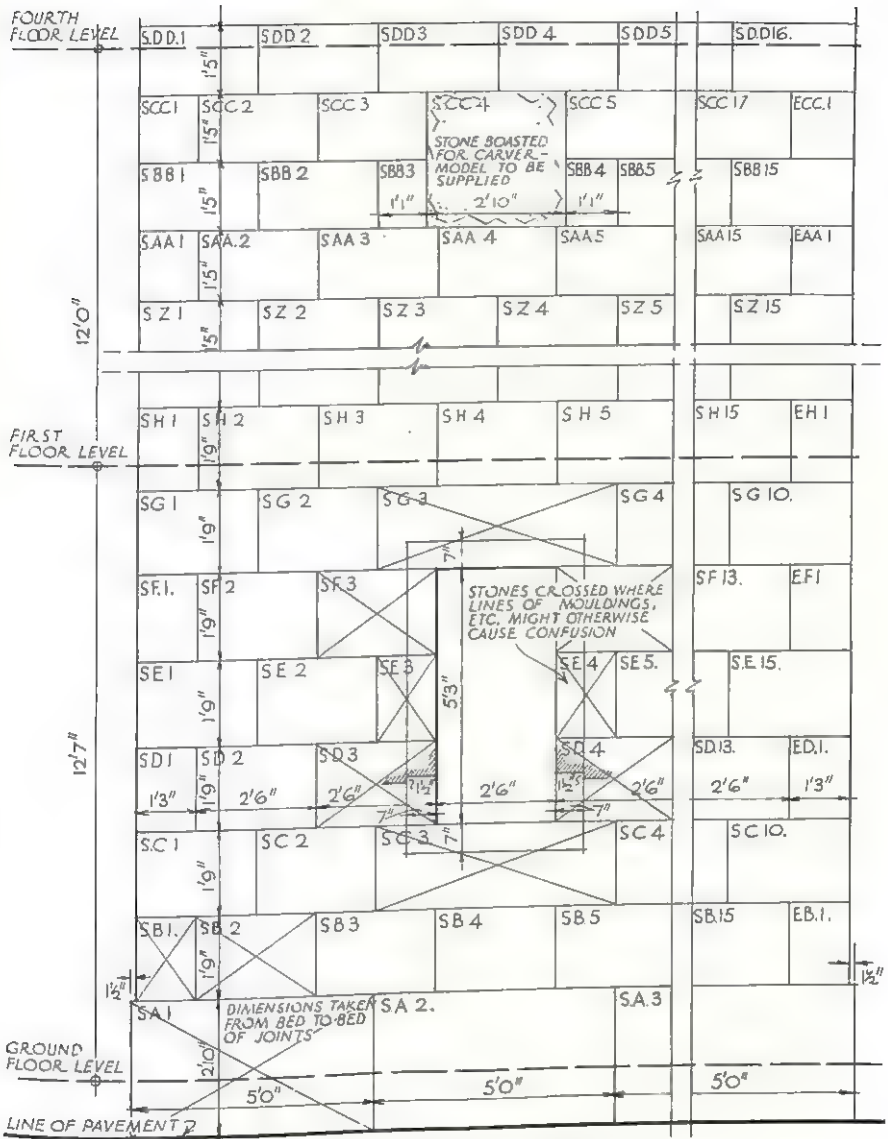

1'4" MIN.
SECTION
ELEVATION
STONES DRAWN SEPARATELY FREEHAND
RANDOM RUBBLE
PLAN
FILL
JOINTS DRAWN IN FREEHAND
SETTING OUT LINES RULED
SECTION
ELEVATION
COURSED RUBBLE
PLAN
RUBBLE BACKING
JOINTS RULED
LINTOL
SECTION
ELEVATION
SNECKED RUBBLE
PLAN

Fig. 87



PART ELEVATION OF ASHLAR WALL
TO SHOW DIMENSIONING, NUMBERING OF STONES, ETC.

MASONRY

Fig. 88

which appear on two elevations take their numbers from the elevation on which the larger faces show. No stone can have two numbers. The numbers are put in the top left-hand corners of the stones on the drawing.

(3) *Timber.*—On plan and section timber frame construction is shown either as a solid black wall of appropriate thickness at small scales or in outline with solid black studs or framing. At $\frac{1}{4}''$ scale and larger it is possible to show the outer and inner facings and to cross the studs, etc., in the conventional manner for unwrought timber. Fig. 89 shows part plan, section and elevation of a small timber building.

On elevation, continuous thin lines are drawn to represent vertical or horizontal boarding as the case may be. Cross joints are not usually shown. Edges which are intentionally irregular can be drawn freehand over ruled construction lines.

(4) *Steelwork.*—Fig. 90 shows the drawing and conventional indication of typical details and sections of structural steelwork.

Steel sections when adjacent and shown solid black to a small scale should have a thin white space—the thickness of a line —left between them.

Fig. 91 shows part of a steel framing plan, the type of drawing, usually at $\frac{1}{8}''$ scale, prepared to show details of the beams at each floor level for a steel frame building. The conventional indication for such a plan is also shown.

It is customary to number stanchions starting from the top left-hand corner of the plan and proceeding from left to right in regular sequence, finishing at the bottom right-hand corner. This method which suits a compact building very well may need to be modified, however, for building with long wings in various directions. Stanchion numbers are enclosed in circles and are put, if possible, to the lower right-hand side of the stanchions to which they refer on plan. Beams generally take their numbers from the stanchion number at the bottom left-hand of the bay. The beam numbers consist of the stanchion numbers as a prefix with the addition of 2, 4, 6, 8 and 0 for beams running horizontally on the drawings, and 1, 3, 5, 7 and 9 for beams running vertically. Beams with no stanchions at their left-hand ends usually take their numbers from the stanchions at their right-hand ends with the prefix 0.[1]

The number of beams must follow the same sequence on each floor, the floor being denoted by a letter prefix: *A* for first floor, *B* for second floor, and so on. The ground floor is prefixed *Z*, the first basement *Y* and the sub-basement *X*. If not otherwise used, *R* can be used for roof plan.

[1] There are variations of this notation, which differs slightly from the method proposed by the British Standards Institution.

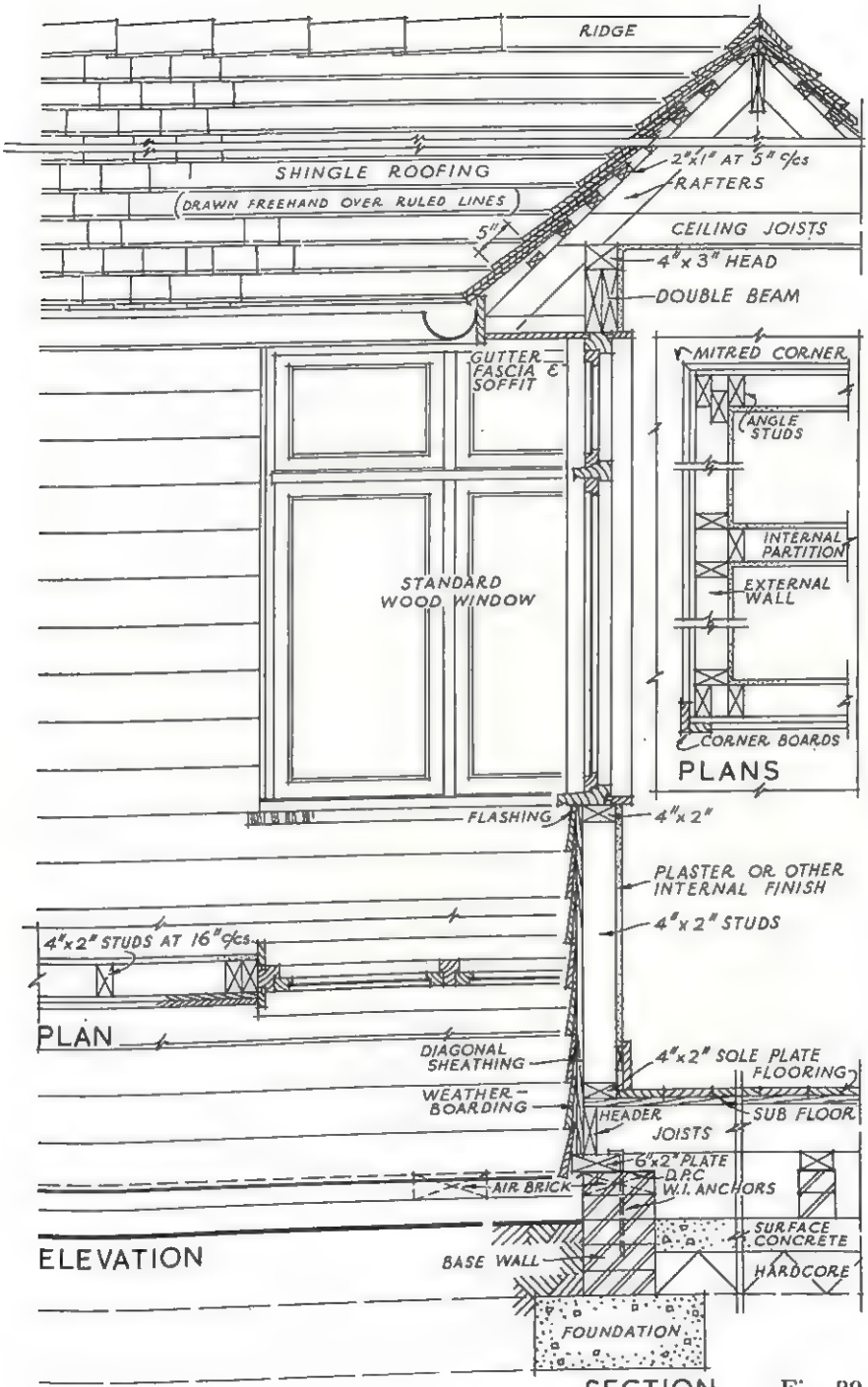
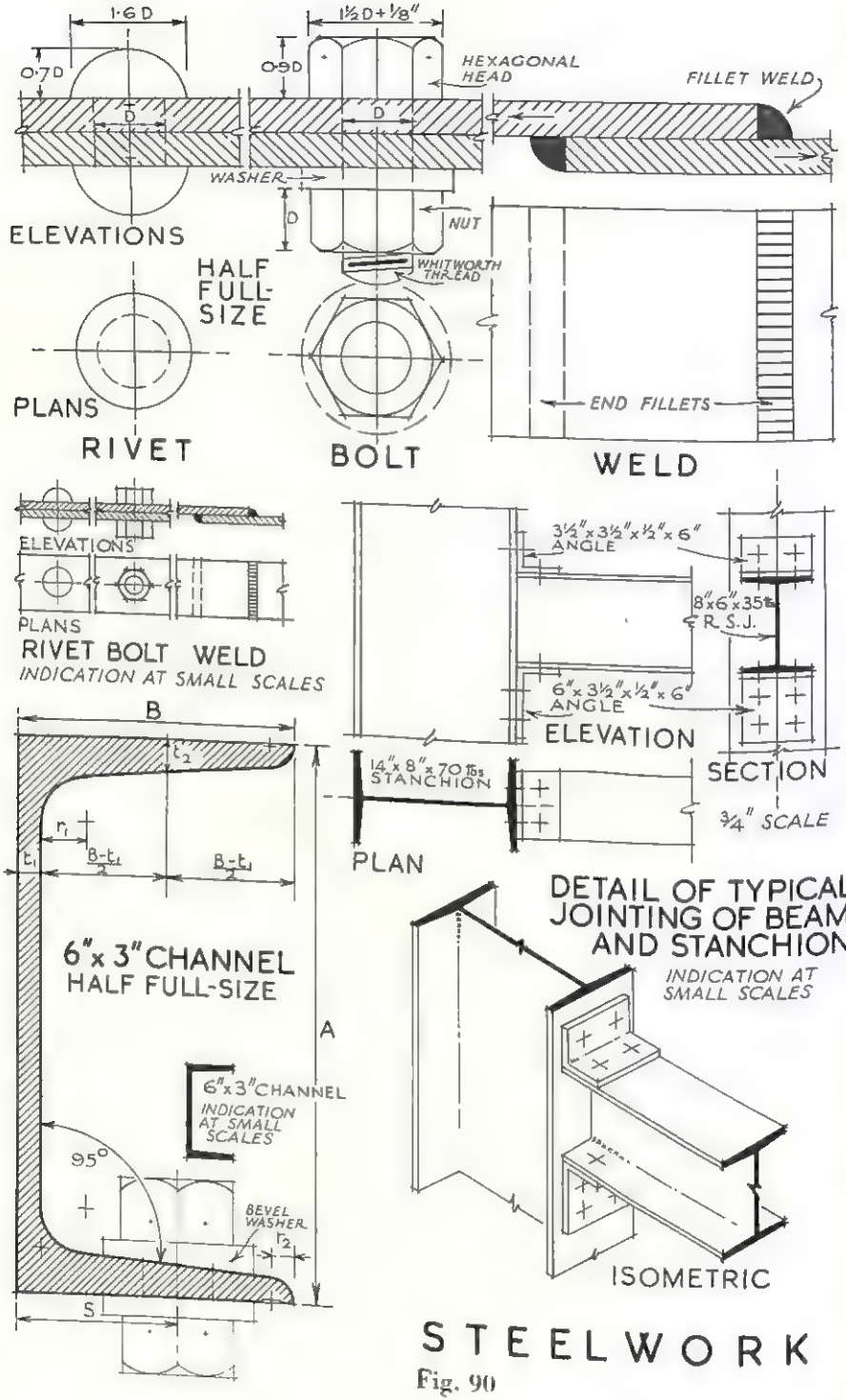
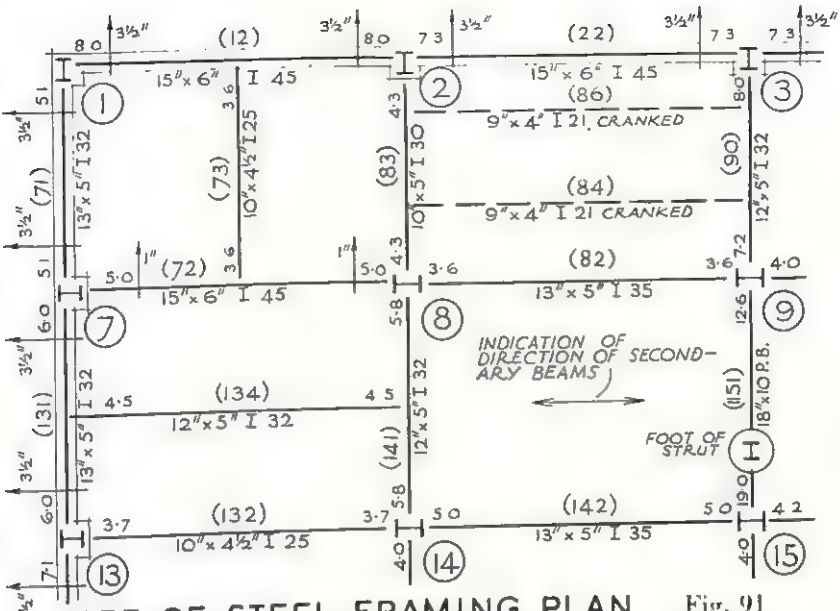

RIDGE
SHINGLE ROOFING
(DRAWN FREEHAND OVER RULED LINES)
2"x1" AT 5" c/cs
RAFTERS
5"
CEILING JOISTS
4"x3" HEAD
DOUBLE BEAM
GUTTER
FASCIA &
SOFFIT
STANDARD
WOOD WINDOW
MITRED CORNER
ANGLE
STUDS
INTERNAL
PARTITION
EXTERNAL
WALL
CORNER BOARDS
PLANS
FLASHING
4"x2"
PLASTER OR OTHER
INTERNAL FINISH
4"x2" STUDS
4"x2" STUDS AT 16" c/cs
PLAN
DIAGONAL
SHEATHING
4"x2" SOLE PLATE
FLOORING
WEATHER-
BOARDING
HEADER
SUB FLOOR
JOISTS
6"x2" PLATE
D.P.C.
AIR BRICK
W.I. ANCHORS
SURFACE
CONCRETE
ELEVATION
BASE WALL
HARDCORE
FOUNDATION
SECTION

Fig. 89



STEELWORK

Fig. 90



PART OF STEEL FRAMING PLAN Fig. 91

STANCHIONS

PLATED STANCHIONS

STANCHION Nos. (13)

BEAMS

PLATED BEAMS P.B.

BEAM NUMBERS AND SIZES (123) 12"×5" I 32

STRUTS H

ECCENTRICITIES 4" 4"

BEAM REACTIONS 5·0 3·6

CRANKED BEAMS

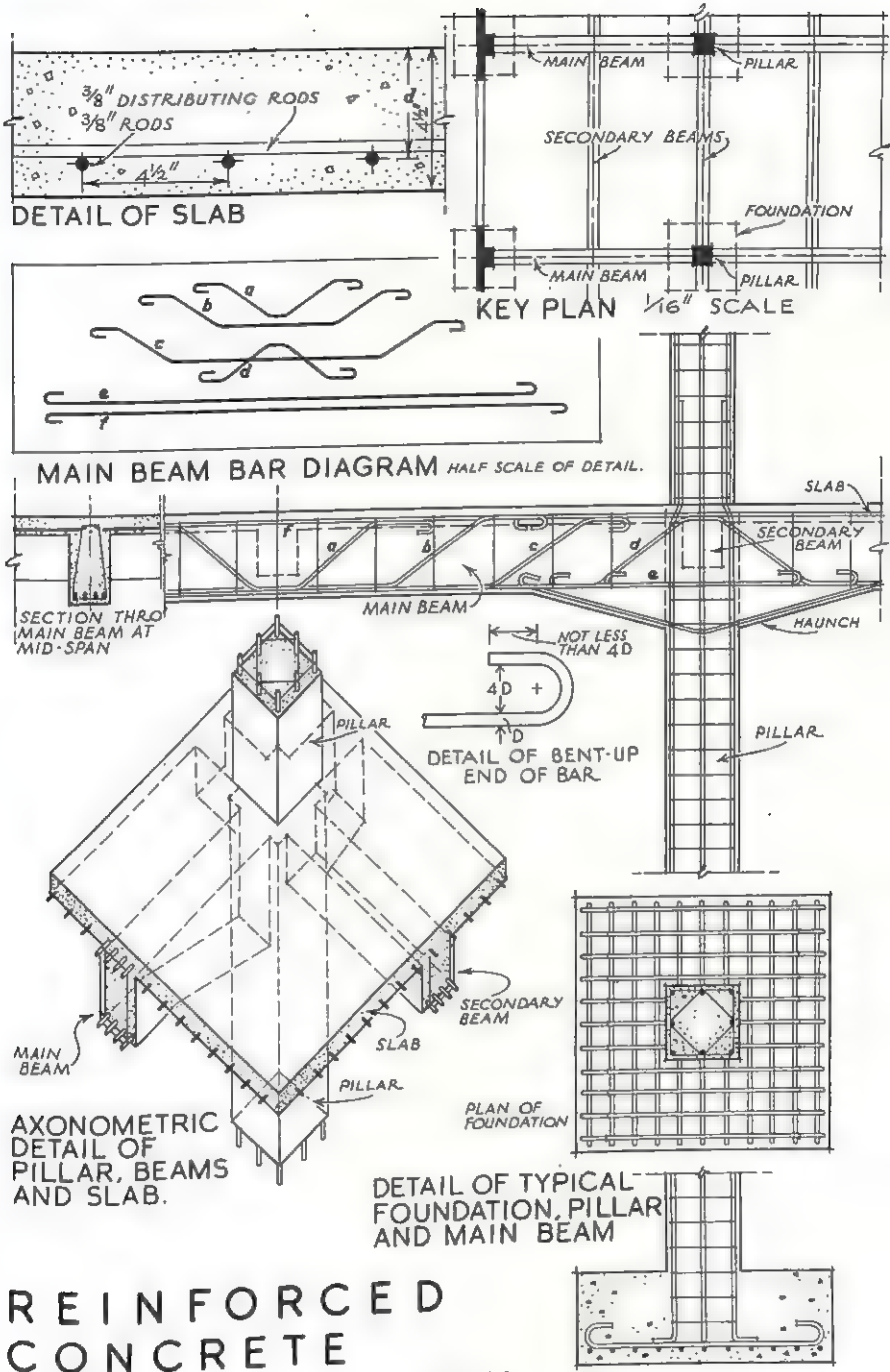
WIND BRACING W.B.

CONVENTIONAL INDICATIONS FOR PLANS

STRUCTURAL STEELWORK

FINISHED THIRD FLOOR LEVEL				
8'0"	11"×10"	12"×10"	14"×12"	11"×10"
FINISHED SECOND FLOOR LEVEL				
9'0"				
FINISHED FIRST FLOOR LEVEL				
10'6"	12"×10"	14"×12"	14"×14"	12"×10"
FINISHED GROUND FLOOR LEVEL				
11'0"		14"×12"		
FINISHED BASEMENT FLOOR LEVEL	13'3"	5'0"	20'6"	13'3"
BASE TYPE No	3	6	5	3
STANCHION No	1	2	3	4

PART OF TYPICAL COLUMN SCHEDULE Fig.



REINFORCED CONCRETE

Fig. 93

Note that steelwork on, say, the third floor framing plan is the steel carrying the third floor, and the stanchions are the ones running from second to third floor.

A typical column or stanchion schedule, sometimes shown on the drawings, is also shown in Fig. 92. Stanchions usually run through two floors and are spliced 1′ 6″ above floor level.

The drawings of a building to be used by a structural engineer, who normally prepares the framing plan as a tracing over the architect's drawings, should show: The nature and thicknesses of all walls; the nature and thickness or the weights of all floor finishes; maximum possible depths for all beams; positions and weights of any heavy loads, such as tanks, machinery, lifts, etc.

(5) *Reinforced Concrete.*—Fig. 93 shows related details of various kinds and at various scales to show the drawing of reinforced concrete construction.

There is no standard method of preparing framing plans and complete reinforcement indication. Specialist firms have their own systems.

Representation and Plan Indication of Various Details and Fittings

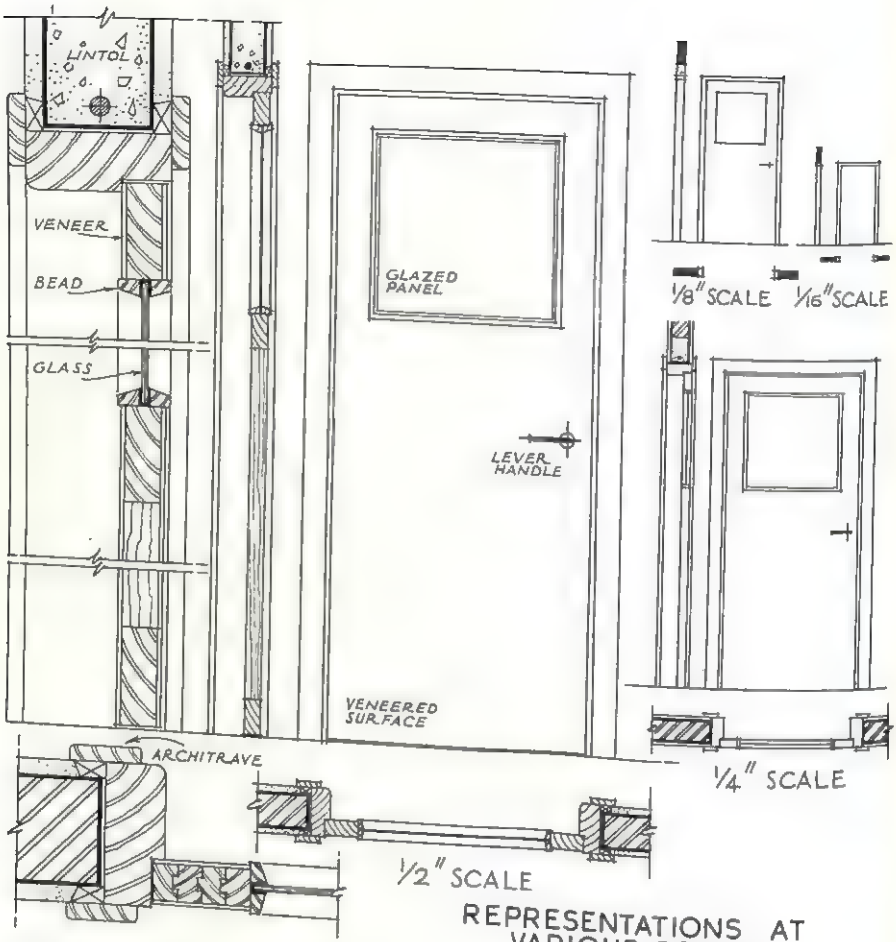
Doors.—Fig. 94 shows an example of the drawing of a door and frame at various scales. The purpose of this is to give some illustration of the amount of detail which can be reasonably included in each case. It is a common mistake to attempt to show too much at the smaller scales. No hard and fast rules can be laid down, however, and it may be permissible to show more in a carefully executed design drawing than in a working drawing.

Fig. 95 shows typical conventional plan indications of doors at $\frac{1}{8}$″ scale. The door is indicated by a single line at right-angles to the wall and the swing of its opening edge by a quadrant or semi-circle. Note that the centre of the arc must be where the pin of the hinge is.

Where the door lines at right-angles to the wall might be confused with other lines on the drawing, they can be shown at a lesser angle provided the indication is consistent throughout the drawing.

Wood Windows.—Fig. 96 shows an example of the drawing of a typical wood casement window at various scales. Double-hung sashes should be denoted at small scales by the letters "D.H.S." on plan and elevation.

Metal Windows.—Fig. 97 shows the representation at various scales of a typical metal window. Note particularly the indication of the metal sections, which cannot be drawn satisfactorily

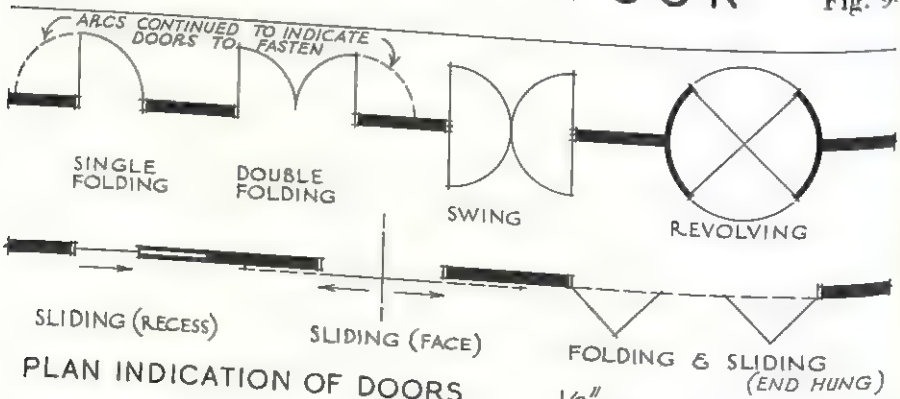


EIGHTH FULL-SIZE DETAILS

REPRESENTATIONS AT VARIOUS SCALES

DOOR

Fig. 94



PLAN INDICATION OF DOORS

1/8" SCALE.

Fig. 95

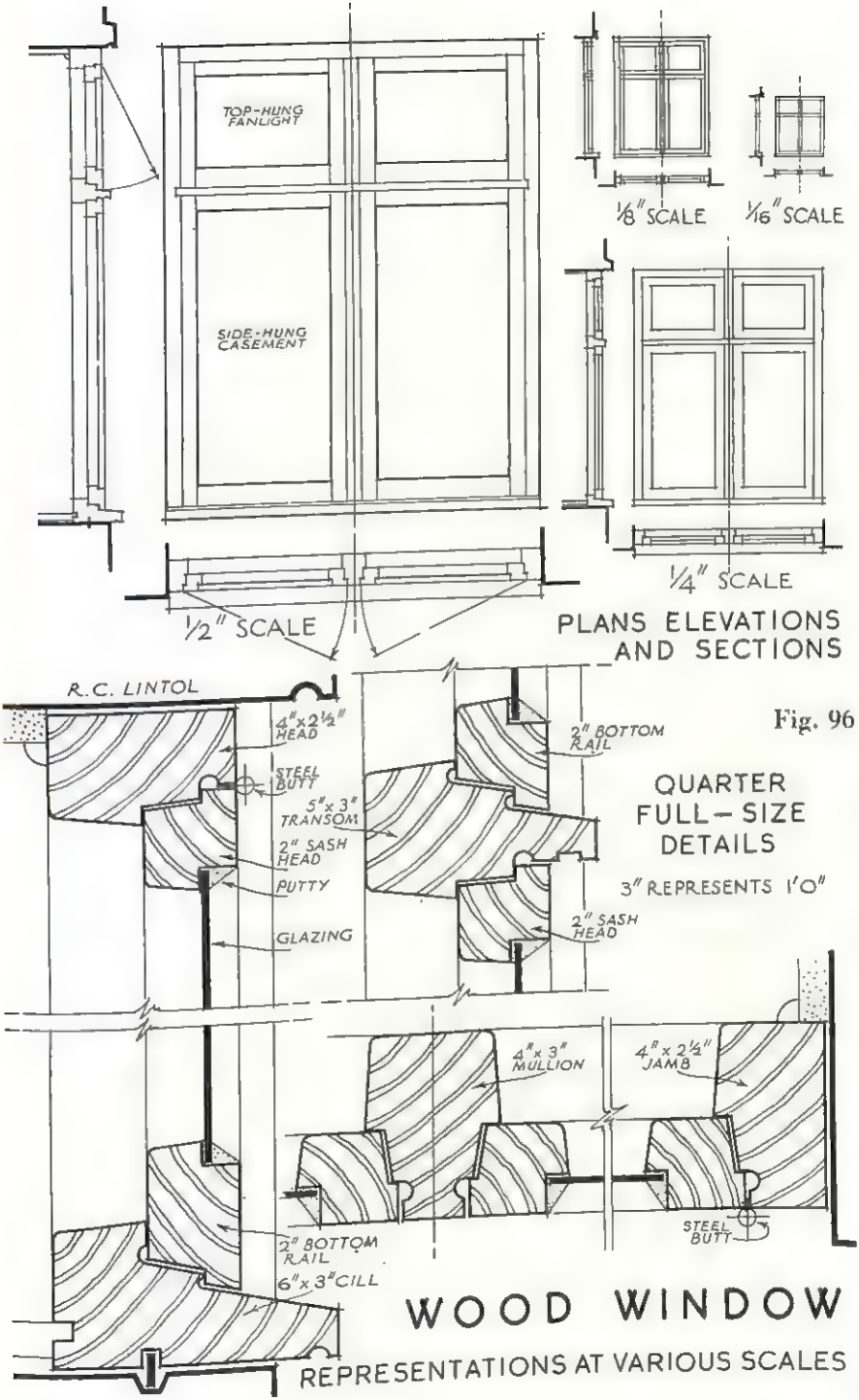
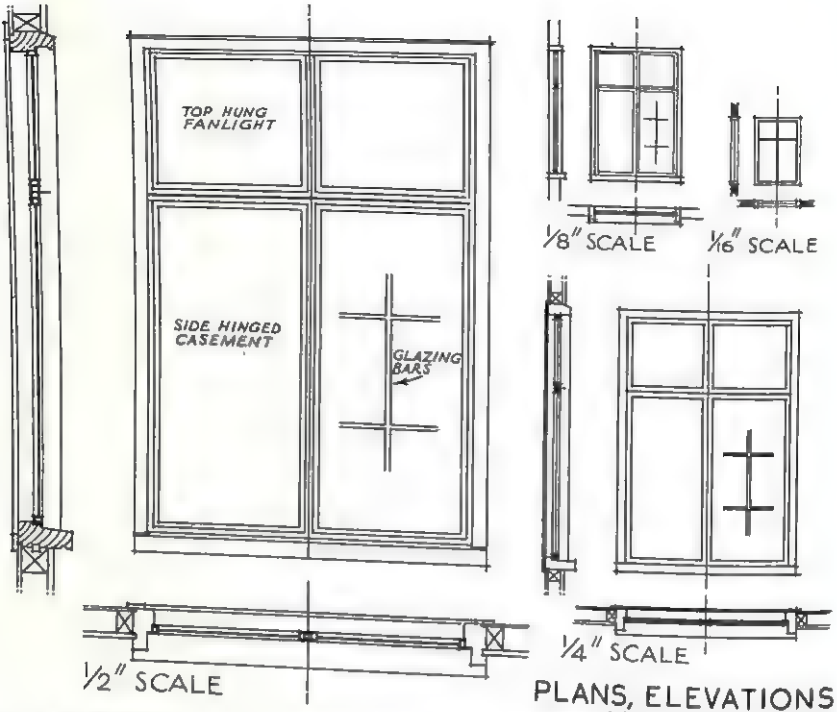
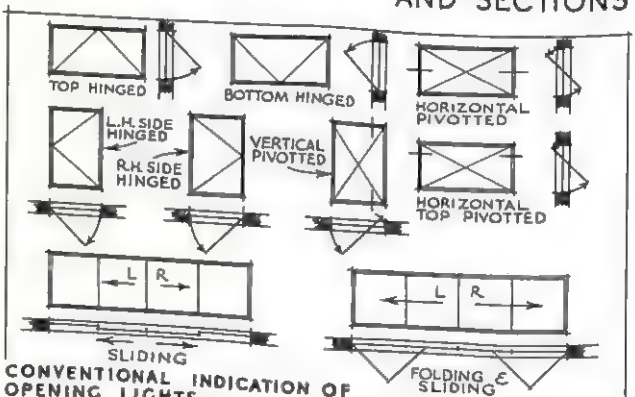

TOP-HUNG FANLIGHT
SIDE-HUNG CASEMENT
1/8" SCALE
1/16" SCALE
1/4" SCALE
1/2" SCALE
PLANS ELEVATIONS AND SECTIONS
R.C. LINTOL
4"x2½" HEAD
STEEL BUTT
5"x3" TRANSOM
2" SASH HEAD
PUTTY
GLAZING
2" BOTTOM RAIL
6"x3" CILL
2" BOTTOM RAIL
2" SASH HEAD
4"x3" MULLION
4"x2½" JAMB
STEEL BUTT
QUARTER FULL-SIZE DETAILS
3" REPRESENTS 1'0"
WOOD WINDOW
REPRESENTATIONS AT VARIOUS SCALES

Fig. 96

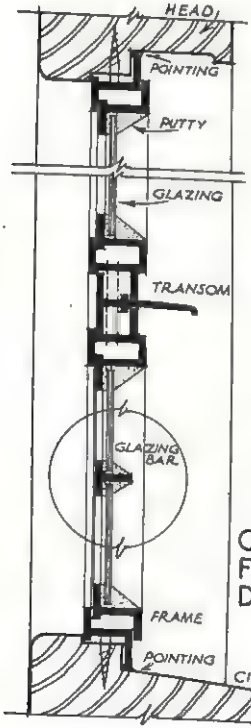


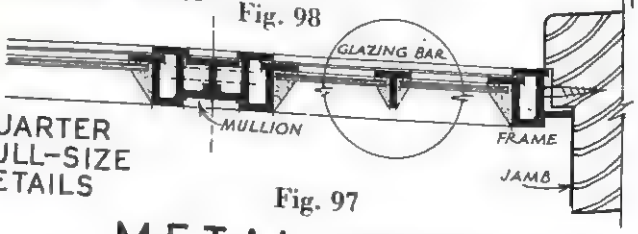
PLANS, ELEVATIONS AND SECTIONS



CONVENTIONAL INDICATION OF OPENING LIGHTS

Fig. 98





QUARTER FULL-SIZE DETAILS

Fig. 97

METAL WINDOW

REPRESENTATIONS AT VARIOUS SCALES

in full at less than 1″ scale. As metal windows are standard products they are not usually detailed except in relation to other construction, and the indication of the opening parts in elevation is therefore all the more necessary. It has been the general practice to cross the opening parts, as shown in Fig. 80, but the conventional indication, shown in Fig. 98, which denotes in addition the hinged side or pivot of the opening is becoming more common for metal windows.[1]

Domestic Kitchen Equipment.—Fig. 99 shows the conventional indication on plan and elevation at $\frac{1}{8}$″ scale of various equipment and fittings.

Sanitary Fittings.—Fig. 100 shows the conventional indication on plan and elevation at $\frac{1}{8}$″ scale of various sanitary fittings. The centres of arcs are shown in some cases, although these would not appear in the drawing. Alternatives are given in the cases of baths, bidets, and W.C.s.

Furniture, etc.—Fig. 101 shows common conventional indications of domestic furniture at $\frac{1}{8}$″ scale. These articles, with the possible exception of beds, are not shown on working drawings unless forming part of the permanent structure.

If known, the sizes can be made to conform to those of the articles to be used, but this is not always the case when $\frac{1}{8}$″ scale drawings are being prepared. To larger scales, $\frac{1}{2}$″, etc., more precise details of the equipment would be given.

Staircases, etc.—Fig. 102 shows the setting-out and indication of various types of staircases. The easiest way of dividing up the floor-to-floor height into the required number of risers or the length of the flight into treads is by using the edge of a scale on the drawing in the manner described on p. 31.

Arrows should be used to indicate the "UP" direction only. The putting of arrows pointing in both directions and labelling them "up" and "dn" respectively is a waste of time and leads to confusion. The first riser can be indicated on the line of the arrow by a dot. All risers should be numbered in order, beginning with the lowest on working drawings, both on plan and section.

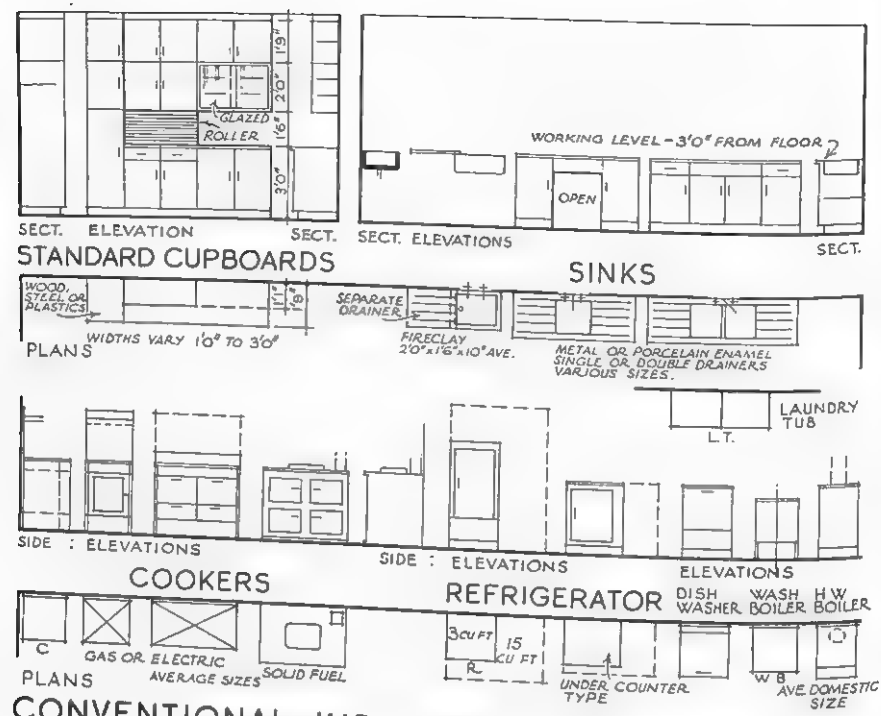
Lifts are indicated as shown; the car usually being crossed.

Ramps should be labelled and have an arrow pointing in the "UP" direction. The angle of rise—15 degrees maximum—should be given on section.

Graphical Symbols

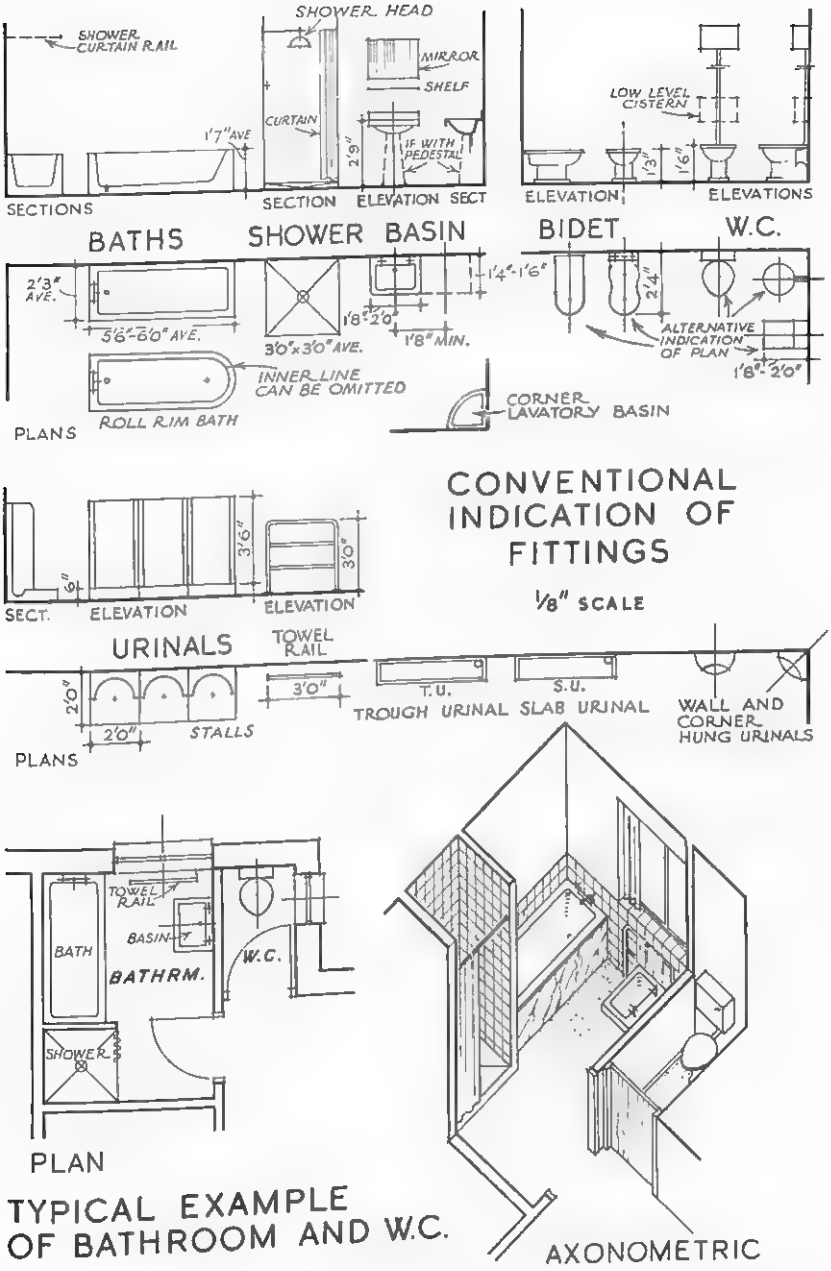
Electric Symbols.—Fig. 103 shows the symbols used in connection with interior electrical installations. These are reproduced from British Standard Specification No. 447.

[1] See British Standards Institution pamphlet No. 990.



DOMESTIC KITCHENS

Fig. 99



SANITARY FITTINGS

Fig. 100

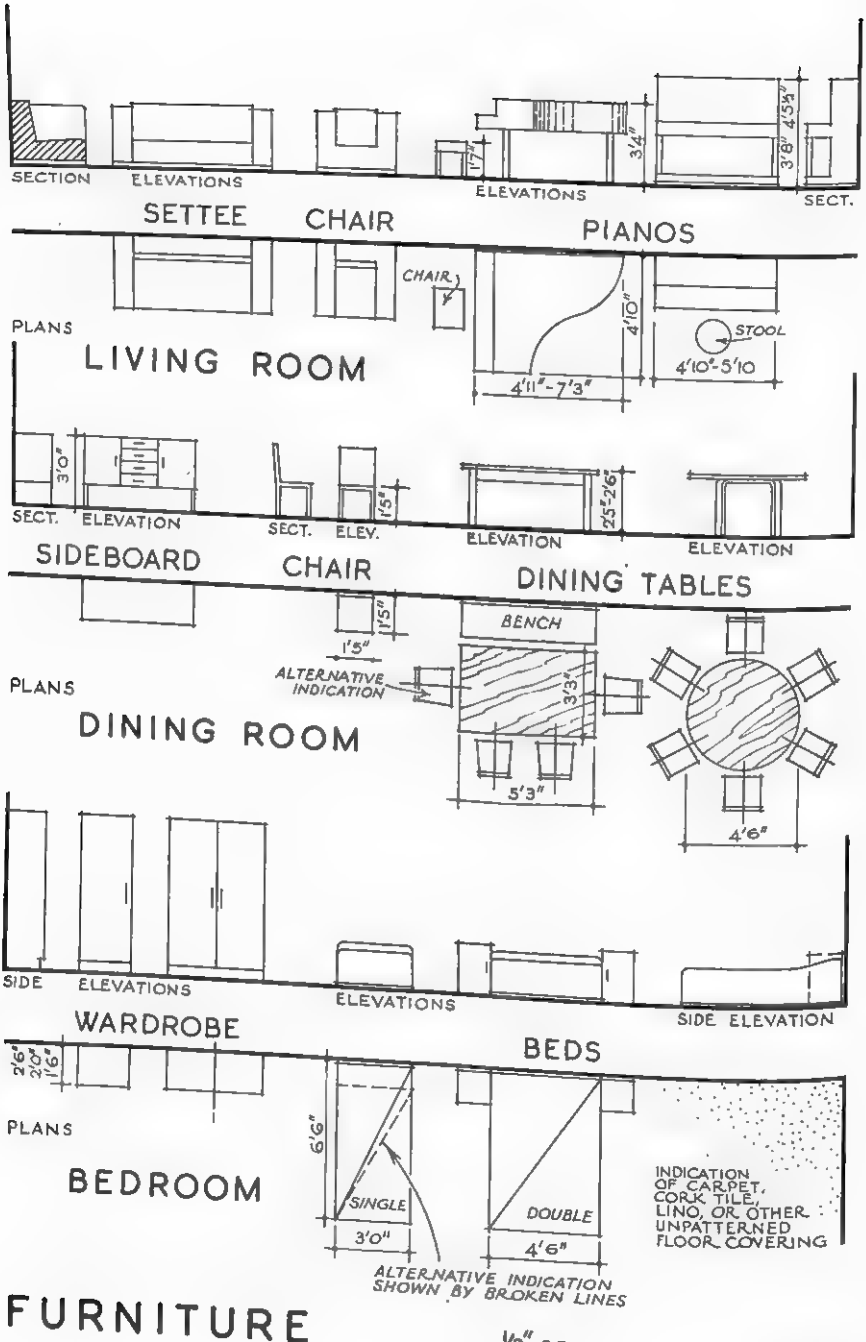
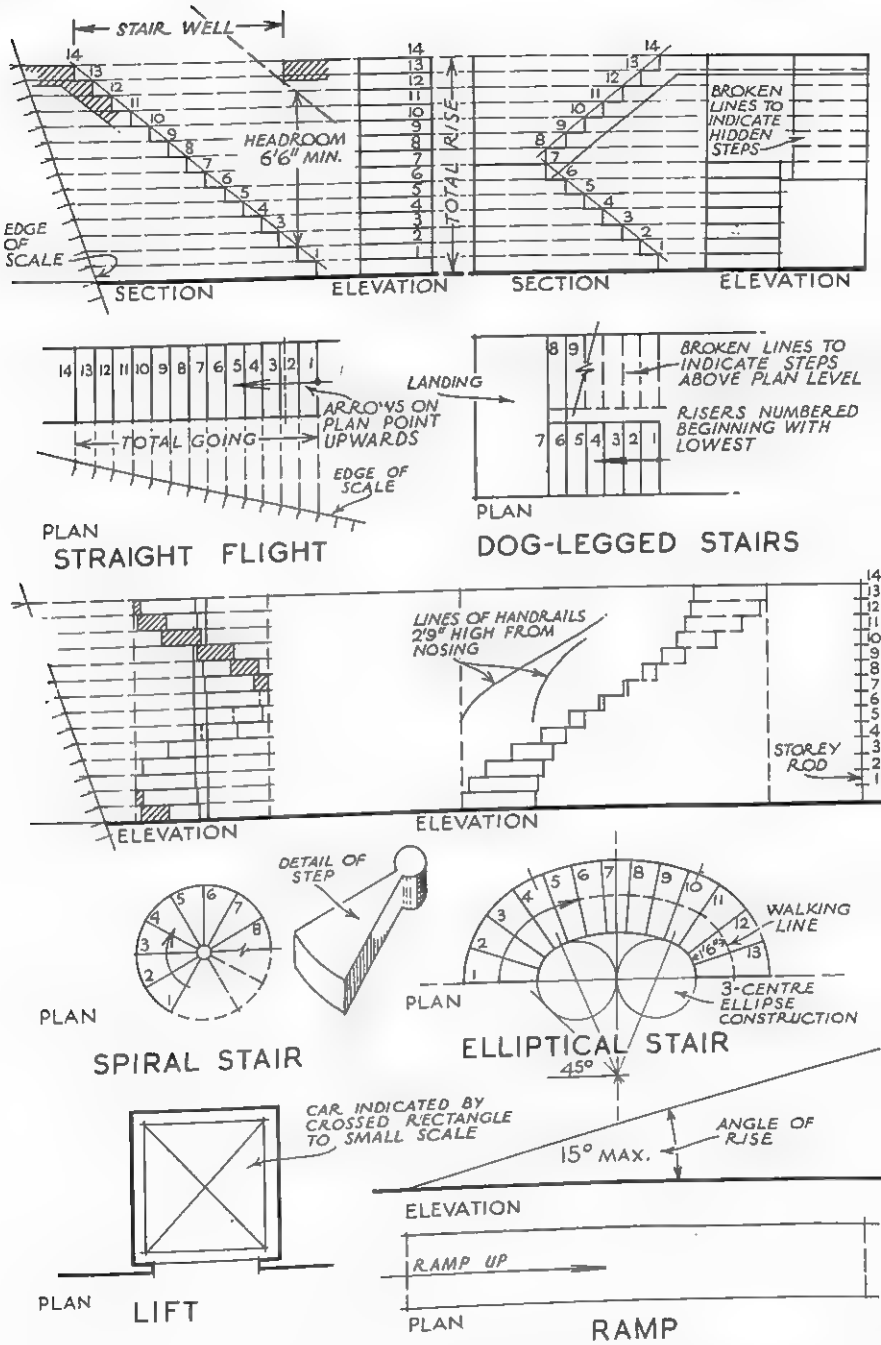

SECTION
ELEVATIONS
ELEVATIONS
SECT.
SETTEE
CHAIR
PIANOS
CHAIR
PLANS
LIVING ROOM
STOOL
4'10"-5'10
4'11"-7'3"
SECT.
ELEVATION
SECT.
ELEV.
ELEVATION
ELEVATION
SIDEBOARD
CHAIR
DINING TABLES
BENCH
ALTERNATIVE INDICATION
PLANS
DINING ROOM
5'3"
4'6"
SIDE
ELEVATIONS
ELEVATIONS
SIDE ELEVATION
WARDROBE
BEDS
PLANS
BEDROOM
SINGLE
DOUBLE
3'0"
4'6"
INDICATION OF CARPET, CORK TILE, LINO, OR OTHER UNPATTERNED FLOOR COVERING
ALTERNATIVE INDICATION SHOWN BY BROKEN LINES
FURNITURE
1/8" SCALE

Fig. 101



STAIRS ETC. INDICATION AND SETTING OUT

Fig. 102

Plumbing, Drainage, etc.—Fig. 104 shows symbols and way of indicating pipe runs and details in connection with plumbing and drainage plans and drawings to show gas, water, heating and ventilation lay-outs, etc.

Example of Working Drawing in Detail

Figs. 105 to 107 illustrate an $\frac{1}{8}$" scale working drawing for an economical 4-bedroom house. The lay-out of the sheet was suggested in Fig. 79. The ground floor plan and the north-east elevation are reproduced actually at $\frac{1}{8}$" scale; the remainder is drawn at $\frac{1}{8}$" scale but reproduced at $\frac{1}{16}$" scale.

The manner of dimensioning and lettering the drawings and the conventional indications have been previously referred to. Note the use of arrows to indicate entrances. It is usual to describe floor finishes of each room on plan; this is done by smaller lettering under the names of the rooms.

Alterations and Additions

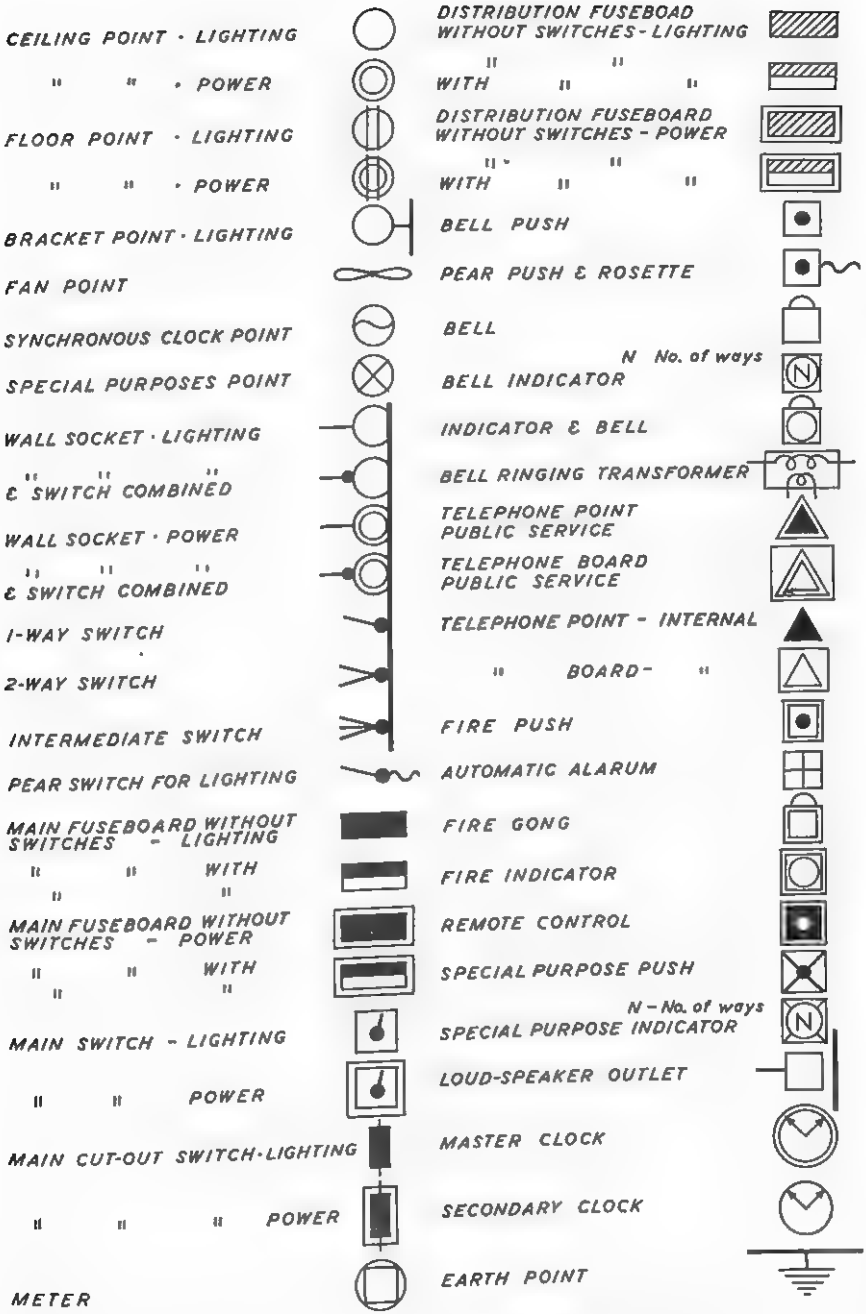
Fig. 109 shows typical exa.nples of the indication and suitable notes for use on drawings showing alterations or additions to existing buildings. The existing and proposed work must be clearly distinguished. Usually only the minimum essential outlines of the former are drawn (see "junction"), the new work being indicated in the normal manner. Existing walls are usually outlined in a heavy black line or blacked in solid. When drawings are coloured the colouring is confined to the new work.

Full-size Details

These are drawings to show details of construction or, less often, designs which cannot be shown sufficiently clearly on small-scale drawings for the setting-out of workshop drawings. They are usually made for carpenters', joiners' and masons' work. They are drawn on detail paper and are largely sectional in type. All members are shown to exact finished shape and size—it is important to remember in this connection that finished sections of joinery are $\frac{1}{16}$" less for each wrought face than the specified size.

The drawing is made in strong pencil line and the sections of each member are outlined with coloured pencils or an $\frac{1}{8}$" band of water-colour in the conventional colours. Lengthy sections are often divided up for convenience, although sometimes they are drawn on a continuous roll of paper.

Tracing paper copies are made of full-size details, unless small in extent, as it is not possible to reproduce them accurately by photo-printing.



SYMBOLS FOR ELECTRICAL SERVICES

Fig. 103

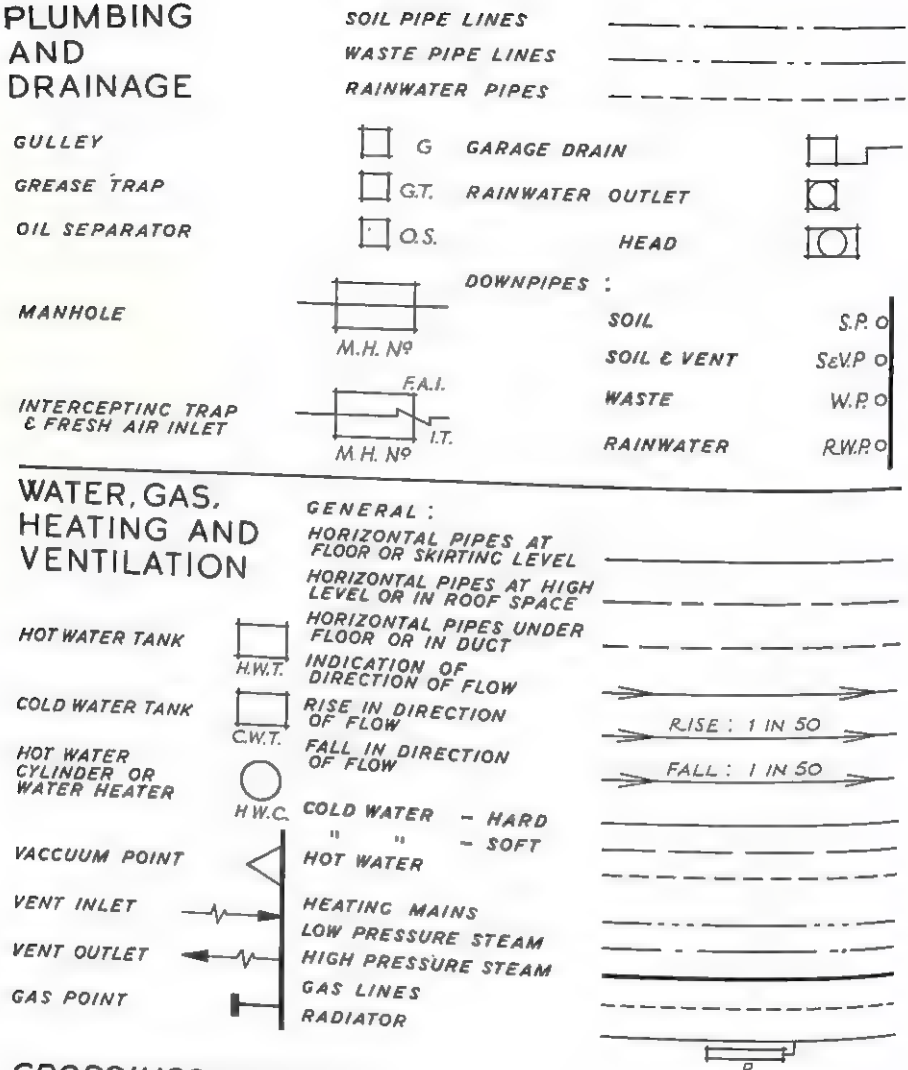
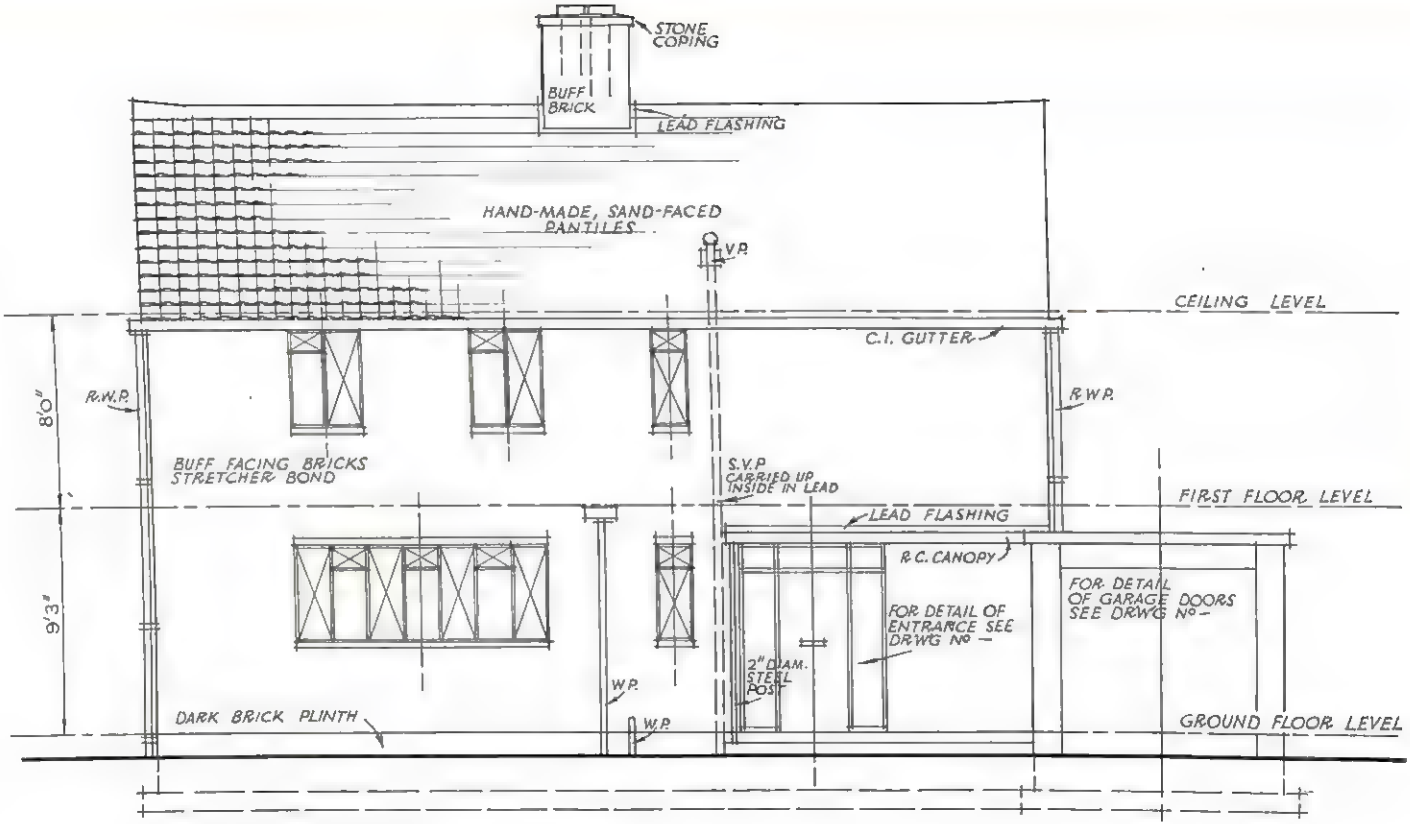
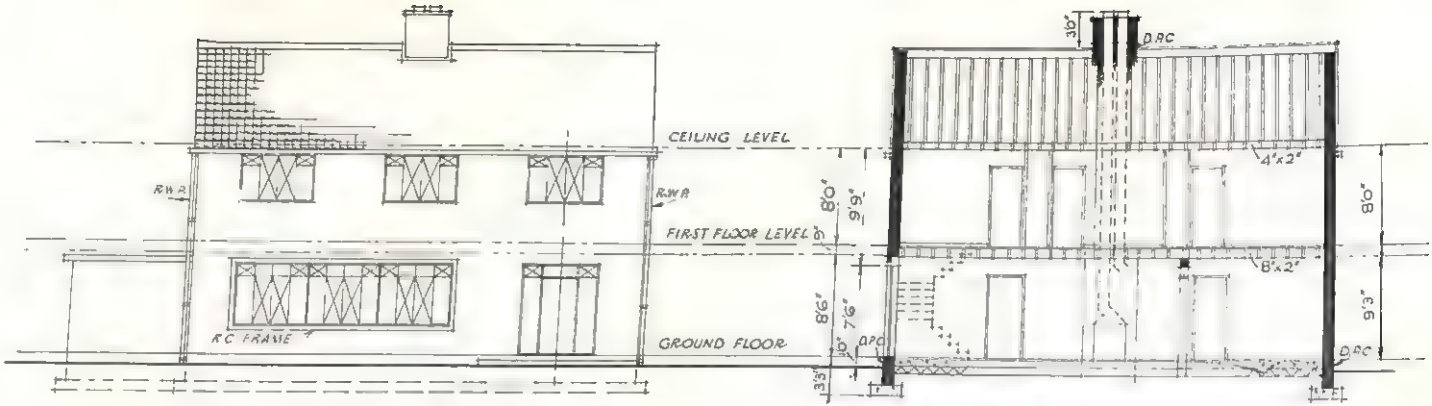

PLUMBING AND DRAINAGE
SOIL PIPE LINES
WASTE PIPE LINES
RAINWATER PIPES
GULLEY
G
GARAGE DRAIN
GREASE TRAP
G.T.
RAINWATER OUTLET
OIL SEPARATOR
O.S.
HEAD
DOWNPIPES :
MANHOLE
M.H. Nº
SOIL
S.P.
SOIL & VENT
S&V.P.
WASTE
W.P.
INTERCEPTINC TRAP & FRESH AIR INLET
F.A.I.
I.T.
M.H. Nº
RAINWATER
R.W.P.
WATER, GAS, HEATING AND VENTILATION
GENERAL :
HORIZONTAL PIPES AT FLOOR OR SKIRTINC LEVEL
HORIZONTAL PIPES AT HIGH LEVEL OR IN ROOF SPACE
HORIZONTAL PIPES UNDER FLOOR OR IN DUCT
HOT WATER TANK
H.W.T.
INDICATION OF DIRECTION OF FLOW
COLD WATER TANK
C.W.T.
RISE IN DIRECTION OF FLOW
RISE : 1 IN 50
HOT WATER CYLINDER OR WATER HEATER
H.W.C.
FALL IN DIRECTION OF FLOW
FALL : 1 IN 50
COLD WATER - HARD
" " - SOFT
VACCUUM POINT
HOT WATER
VENT INLET
HEATINC MAINS
VENT OUTLET
LOW PRESSURE STEAM
HIGH PRESSURE STEAM
GAS POINT
GAS LINES
RADIATOR
R
CROSSINGS TEES & VALVES
CROSSINC LINES NOT CONNECTED
THREE WAY VALVE OR COCK
CROSS
FOUR WAY VALVE OR COCK
TEE
NON RETURN VALVE
VALVE OR COCK
REDUCINC VALVE
ANCLE VALVE OR COCK.
SAFETY VALVE

Fig. 104



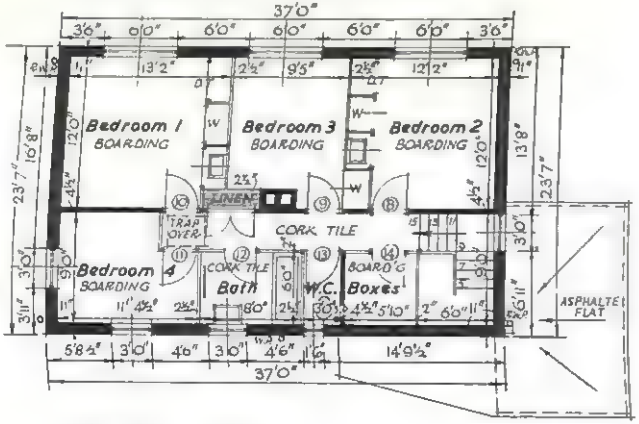
NORTH - EAST ELEVATION

Fig. 105

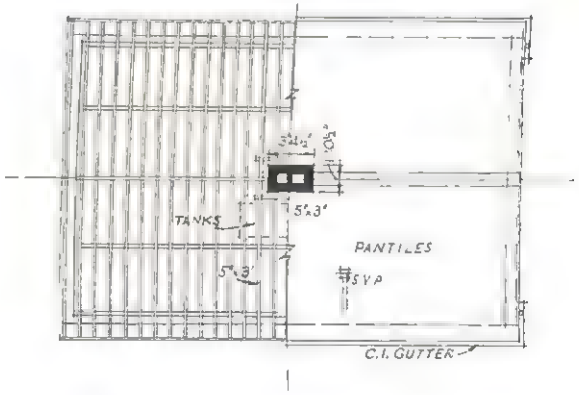


SOUTH-WEST ELEVATION

SECTION A-B



FIRST FLOOR



ROOF PLAN

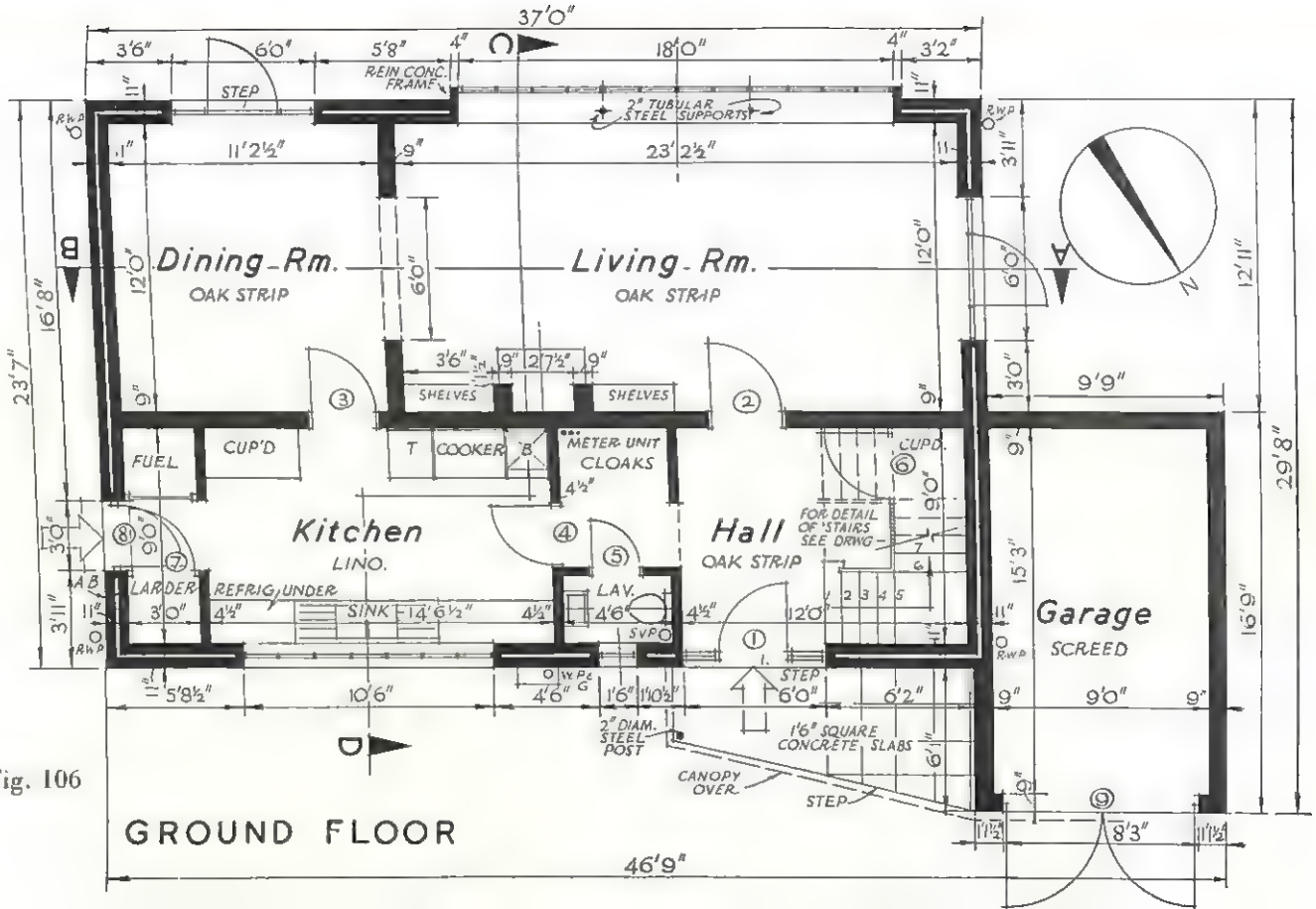
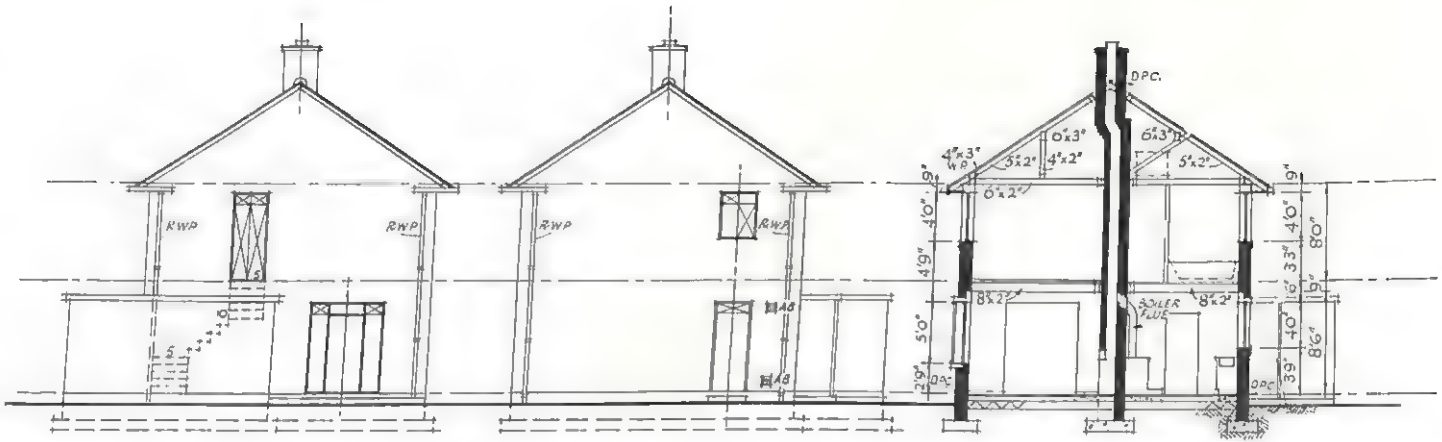

37'0"
3'6"
6'0"
5'8"
4"
18'0"
4"
3'2"
REIN CONC. FRAME
STEP
2" TUBULAR STEEL SUPPORTS
11'2½"
9"
23'2½"
3'11"
12'11"
29'8"
23'7"
16'8"
12'0"
Dining-Rm.
OAK STRIP
Living-Rm.
OAK STRIP
6'0"
3'6"
9"
2'7½"
9"
SHELVES
SHELVES
9'9"
3'0"
FUEL
CUP'D
T
COOKER
B
METER UNIT
CLOAKS
CUP'D
4½"
9'0"
Kitchen
LINO.
Hall
OAK STRIP
FOR DETAIL OF STAIRS SEE DRWG
LARDER
REFRIG. UNDER
SINK
14'6½"
LAV.
4'6"
SVPO
12'0"
15'3"
Garage
SCREED
16'9"
STEP
6'0"
6'2"
9'0"
5'8½"
10'6"
4'6"
1'6"
1'10½"
2" DIAM. STEEL POST
1'6" SQUARE CONCRETE SLABS
CANOPY OVER
STEP
8'3"
46'9"
GROUND FLOOR

Fig. 106



NORTH-WEST ELEVATION SOUTH-EAST ELEVATION SECTION C-D

TYPICAL EIGHTH SCALE WORKING DRAWINGS

REPRODUCED AT SIXTEENTH SCALE

Fig. 107

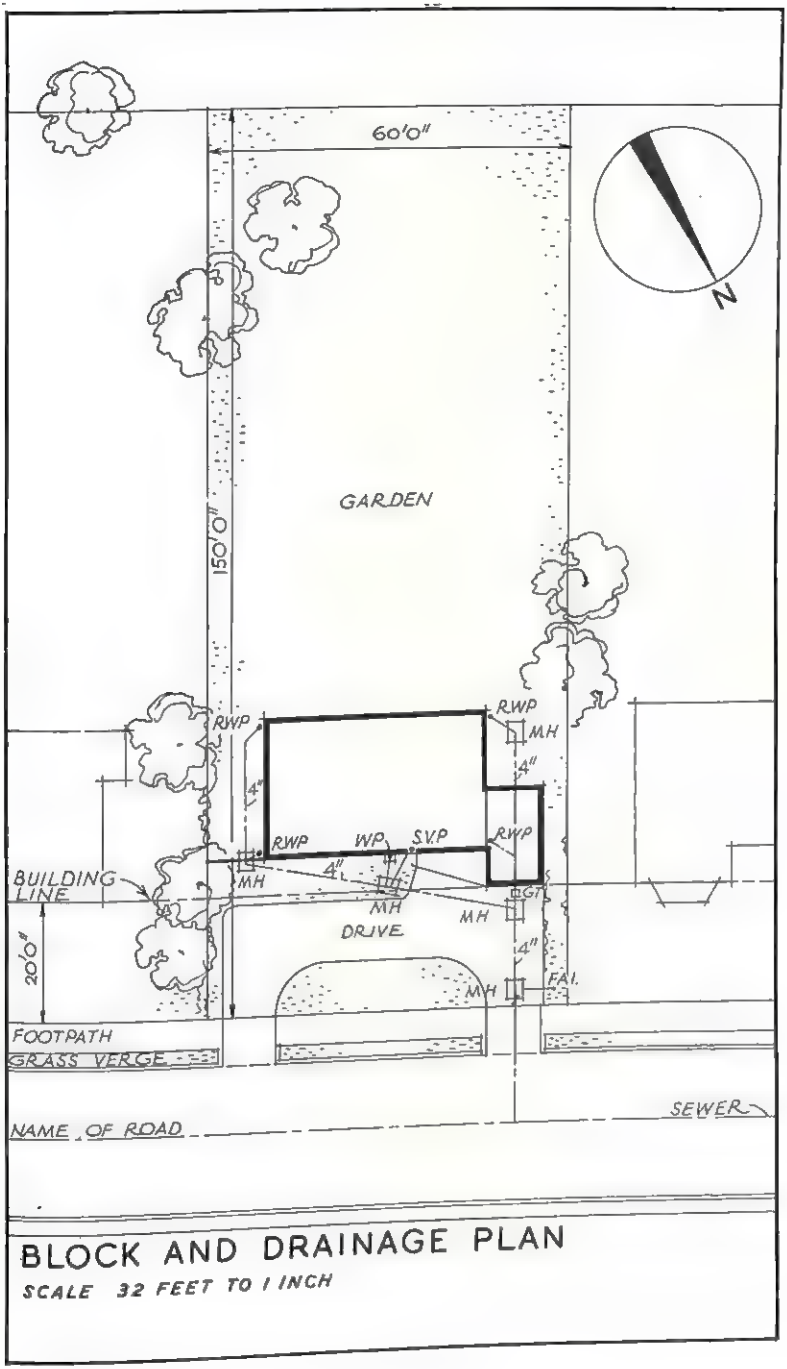
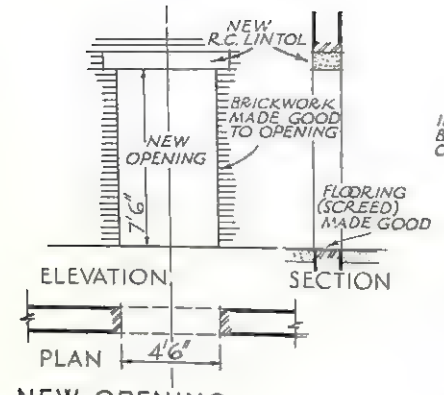
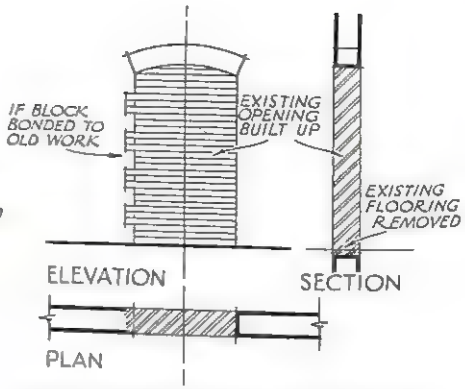

60'0"
N
GARDEN
150'0"
RWP
RWP
M.H
4"
4"
RWP
WP
S.V.P
RWP
BUILDING LINE
M.H
4"
M.H
G.I
M.H
DRIVE
20'0"
4"
M.H
F.A.I
FOOTPATH
GRASS VERGE
SEWER
NAME OF ROAD
BLOCK AND DRAINAGE PLAN
SCALE 32 FEET TO 1 INCH

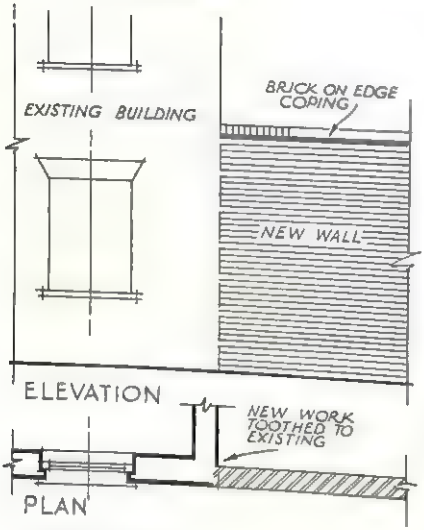
Fig. 108



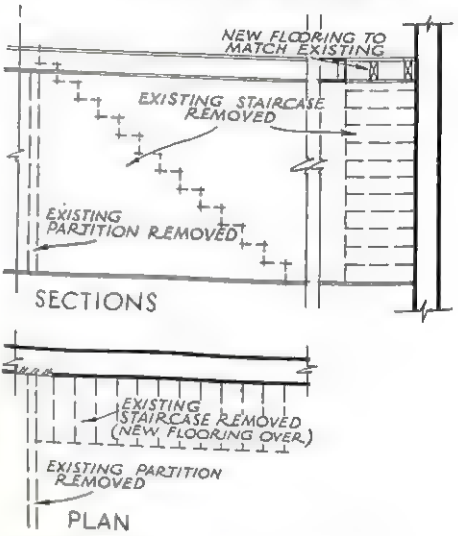
NEW OPENING



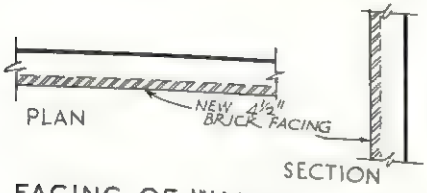
EXISTING OPENING CLOSED



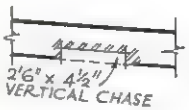
JUNCTION



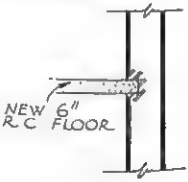
EXISTING WORK REMOVED



FACING OF WALLS



CHASE

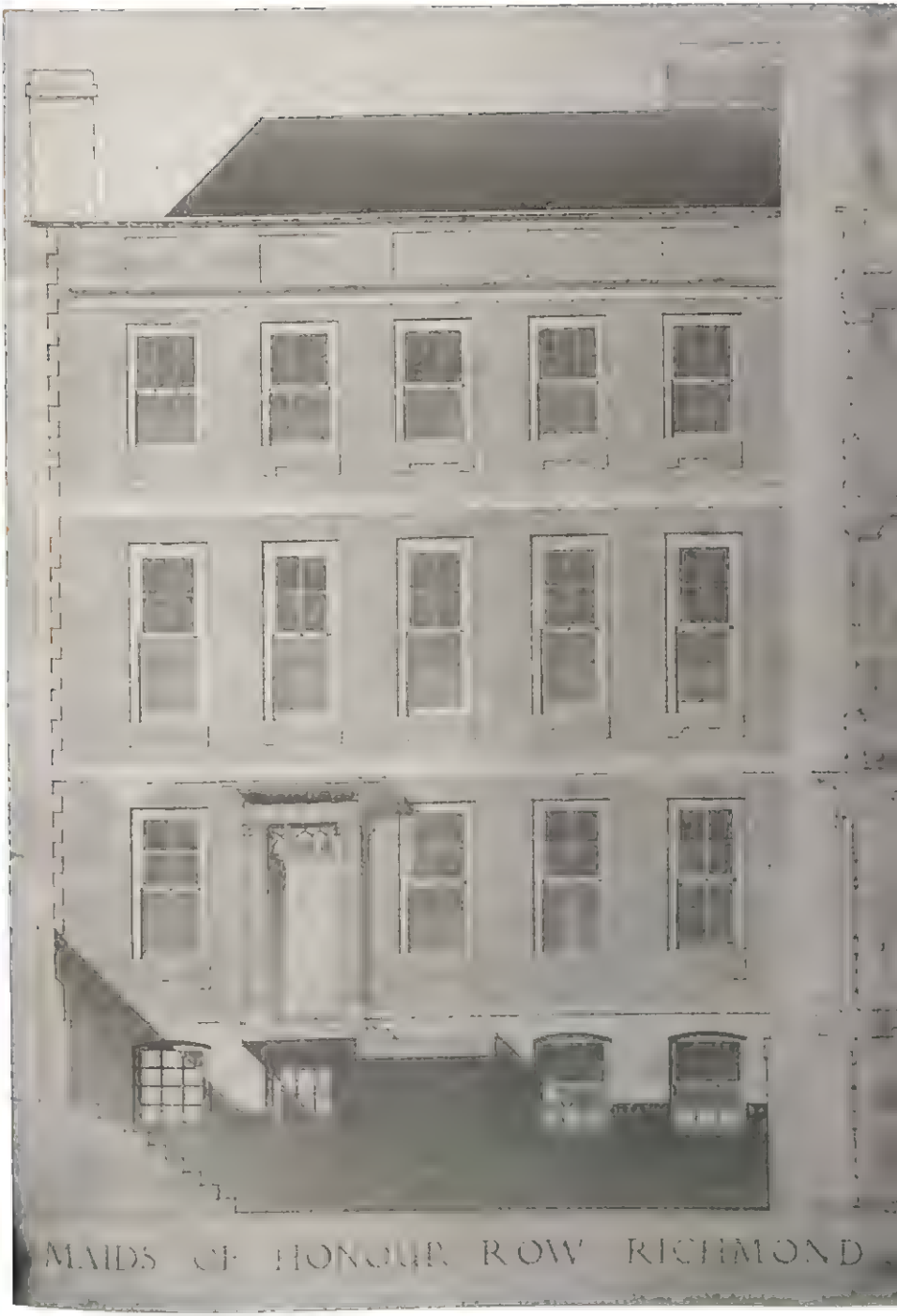


NEW FLOOR

ALTERATIONS AND ADDITIONS

TYPICAL EXAMPLES OF INDICATION ⅛" SCALE

Fig. 109



EXAMPLE OF STUDENT'S DRAWING

Workshop Drawings

These further working drawings, nearly always to full size, are usually made by foremen or special "setter-outs" in the workshops of the various trades, etc., from the architect's scale drawings and full-size details. Sometimes, however, architects prefer to make the workshop drawings themselves.

From these workshop drawings the working lines are transferred to the material or templates. They are made on thick cartridge paper or on specially prepared boards of straight-grained timber or sheets of plywood about 8′ 0″ long. The boards are termed "rods". Their surfaces are glass-papered and covered with a thin coating of whitewash and size or are chalked over, and the drawing is done with a strong pencil line. Coloured pencils are sometimes used to emphasise sections.

Fig. 110 shows two setting-out rods, one for a four-panelled door, the other for a cupboard with sliding doors. The boards bear job numbers and sometimes the various members of the work are given reference numbers.

Check List for Working Drawings

The following refers to some of the main points to be dealt with in making working drawings. All of them may not apply to every job, and other items can be added to the list according to individual ideas. Such a list does, however, help to avoid omissions.

General

1. Careful arrangement of sheets and drawings for maximum legibility and help to users.
2. Use of standard signs, hatching and symbols.
3. Compliance with Building Act, Byelaws, etc.
4. Dimension lines and dimensions; agreement of total lengths, etc.
5. All necessary notes, labelling, titles, north-point, scale, etc.
6. Indication of entrances.
7. Direction of stairs, numbering of risers.
8. Numbering of doors, windows and other plan units.
9. Door swings.
10. Floor finishes.
11. Direction of ramps.
12. Sanitary fittings. Only fittings made or ordered by Contractor to be shown.
13. Positions of artificial light points, etc.
14. Positions of radiators.
15. Positions of service points.
16. Levels in relation to ordnance or other datum.

Basement Plan

1. Foundations of structural walls.
2. Steppings in site and foundation concrete.
3. Tanking.

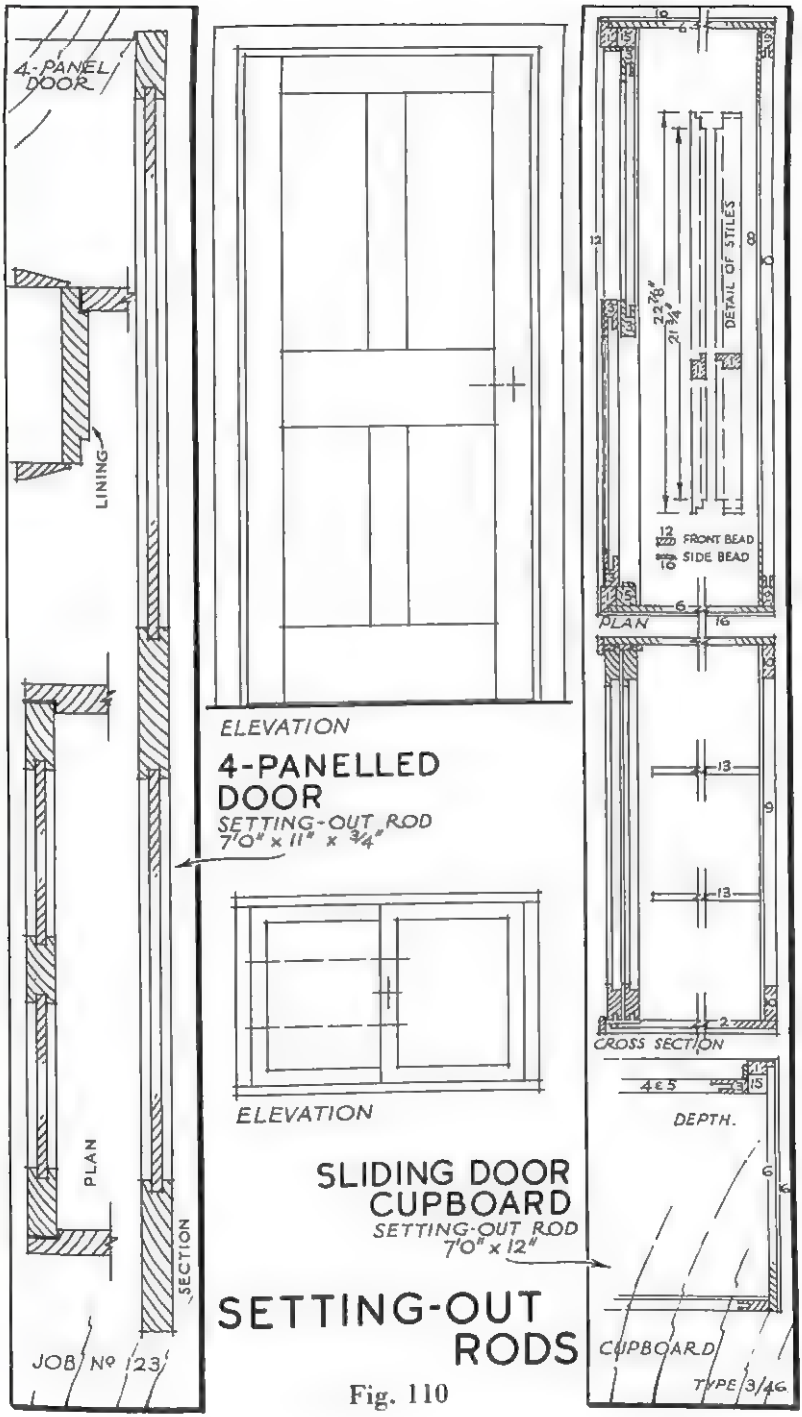

4-PANEL DOOR
LINING
PLAN
SECTION
JOB Nº 123
ELEVATION
4-PANELLED DOOR
SETTING-OUT ROD
7'0" x 11" x 3/4"
ELEVATION
SLIDING DOOR CUPBOARD
SETTING-OUT ROD
7'0" x 12"
SETTING-OUT RODS
DETAIL OF STILES
FRONT BEAD
SIDE BEAD
PLAN
CROSS SECTION
DEPTH.
CUPBOARD
TYPE 3/46

Fig. 110

Basement Plan—contd.

4. Casing of steelwork, numbering of stanchions, etc.
5. Thickness of heating chamber walls, fire-clay lining to flues.
6. Positions of boilers, etc.
7. Finished level of heating chamber floor and surface concrete.
8. Electrical intake and switch room.
9. Boiler room sump.
10. Drainage of areas.
11. Ducts for pipes.
12. Gullies.
13. Drainage pipe lines, manholes, invert levels and arrows to show direction of fall, interceptor and f.a.i.

Ground and Upper Floors

1. Site lay-out.
2. Numbering of stanchions, etc., steel beams, sizes, weights, levels.
3. Sleeper walls dotted.
4. Directions of floor spans.
5. Ducts. Flues.
6. Drainage lines, manholes, etc.; rainwater, soil, vent pipes, etc.
7. Fuel chute.
8. Railings to areas.

Roof Plan

1. Direction of falls.
2. Positions of rainwater pipes, vent pipes, etc., cesspools, rainwater heads.
3. Tanks and circulation.
4. Stacks.
5. Type of covering.
6. Directions of spans.
7. Access to roof.

Elevations and Sections

1. Levels of floors, etc.
2. Dimensions of heights of windows, etc.
3. Joint lines.
4. Stonework blocks crossed where necessary.
5. Joints of all unit materials.
6. Types, numbers and openings of windows.
7. Exposed pipes, gullies, etc., to be shown.
8. Air-bricks, to rooms and timber ground floors, etc.
9. Foundations and steppings—show by broken line on all elevations.
10. Steps, ramps, railings, etc.
11. Existing ground line, finished paving line.
12. D.P.C.s. Tanking.
13. Stacks.

CHAPTER VI

TRACINGS AND REPRODUCTION OF DRAWINGS

TRACINGS are made for the purpose of copying original drawings, either the tracings themselves being used as copies or, usually, as negatives for the production of photo-prints. See p. 20.

Tracings can be made in pencil or Indian ink. Pencil tracings can only be made satisfactorily on tracing paper and are only suitable for certain types of reproduction and, even with these, the results are less clear than with ink tracings. Pencil tracings are therefore only used when there is comparatively little small-scale detail shown and when few copies are required. A hard pencil or one specially made for the purpose should be used, and lines must be firm and clear.

Ink tracings, using the ruling pen, etc., are made on tracing linen or stout tracing paper. The latter material is tending to supersede the former. Paper is usually reinforced along the edges with a strong tape to prevent tearing, after the tracing has been made. The tape is put on by a special machine and is often done by photo-printing firms.

It is essential that the drawing to be copied should itself be clear and accurate. As little setting-up and preliminary drawing as possible should be done on the tracing linen or paper, although it is not always necessary to show detail, lettering, etc., which can be put in straightaway, on the original.

Before being used, tracing linen should be allowed to stretch in the atmosphere where the work is to be done, as the material is affected by moisture in the air when coming straight off the roll. After being cut to the required size allowing for a $\frac{1}{2}''$ margin, it can be hung up by two drawing-pins or left lying flat in some convenient place for several hours, preferably overnight. The selvedges, the outside roll edges of the sheet, should be torn off before the stretching.

The better side of tracing linen for inking—contrary to the belief of many engineers, whose advisers have probably never made the simple experiment of trying both sides—is the one with the dull surface, not the glossy. A little french chalk or wood powder should be rubbed gently over the surface with a soft cloth when the linen has been pinned down over the drawing to be traced. This is done to remove any grease and to assist the flow of ink, but all superfluous powder must be dusted off or it will clog the pen. More than one application of powder may be necessary in the course of making the

tracing. The surface should be touched by the hand as little as possible.

Unless the tracing can be completed in one operation, it is better to divide it into convenient sections to be completed in turn. This will avoid any difficulty due to movement of the linen, especially if it has not been possible to allow adequate time for stretching.

The general sequence of lines, etc., should be as given for inking-in on p. 29. Lines should not be too thin, they must be strong enough to print well, and they should be of even thicknesses according to their purposes. Main outlines can be thickened for definition. Detail which is not to receive particular prominence can be drawn in a hard pencil, e.g. brick courses. Dimensions and lettering must be neat and legible. For titles, "Uno" stencils are very satisfactory.

Ink tracings are difficult for the beginner, and smudging and ragged lines are common occurrences until experience has shown the way to avoid them. Always keep a piece of paper handy for trying out the pen and a cloth to wipe it clean. In warm weather, when the ink sometimes sticks, it can be diluted with a small quantity of water.

Smudges, blots and incorrect lines can be removed with a hard rubber (see p. 12) or by means of special liquid solvents, which are, however, rather messy in use. Any unwanted pencil lines or general dirt can be removed from the surface of tracing linen on completion by wiping it with a rag or piece of cotton wool dipped in petrol, lighter fuel or similar spirit.

Tracings are seldom coloured. Coloured linen tracings are sometimes used for attaching to title-deeds or for submission to local authorities for approval under Bye-laws. The colouring is done on the glossy side in water or poster colour; it appears satisfactorily on the other side.

Reproduction of Drawings

The following are the chief types of "prints" or mechanically produced copies of drawings:

(1) Ferro-prussiate or, more commonly, blue prints. These show white lines on a blue background on paper. They stand a fair amount of handling on building sites, etc., without becoming obscured by dirt, but are rather trying to the eyes, and cannot be satisfactorily coloured. They are largely superseded by type (2).

(2) Dye-line prints. Give brown or black lines on a white background on paper, mounted paper, opaque cloth, translucent paper and translucent cloth. They take colour reasonably well.

(3) Ammonia gas-developed prints (various trade names). Similar to (2) giving a blue line usually. Objection to them is the ammonia smell.

(4) Ferro-gallic prints. Give an indigo-black line on a white background on paper, mounted paper and opaque cloth. This type has also been largely superseded by (2).

The above are comparatively inexpensive and can be made from both ink and pencil tracings, but a certain amount of shrinkage takes place. More accurate copies as regards scale can be obtained in the following:

(5) "True to Scale" (T.T.S.) prints. Give a black ink line on a background of ordinary paper, mounted paper, opaque cloth, tracing paper and tracing linen. These prints do not fade or deteriorate and take colour very well. Additions made to them in Indian ink match the printed lines almost exactly. Parts of tracings can be omitted without difficulty in the printing so that alterations can be easily made. The prints must be made from ink tracings. Prints made on tracing paper or tracing cloth can be reproduced like any original ink tracing; such prints can be "bronzed", a process which strengthens the lines and is advisable if a large number of copies are subsequently to be taken off them.

It is becoming a common practice for contractors on remote sites to be supplied with tracing paper prints, usually by this method, so that they can obtain further reproductions as required.

In addition to the contact types of prints referred to above, various photographic reproductions can be made not only of tracings, but of any drawing, map, print, etc., on film, paper, translucent paper and cloth.

(6) Bromide prints are of this kind. Enlargements and reductions can be made, and by special apparatus reduced size prints can be rapidly produced for convenience and safety in storage and transport; these reductions can be enlarged when required for use.

CHAPTER VII

PROJECTIONS

Metric Projections

METRIC projections are methods of drawing buildings or objects so as to give an impression of actual three-dimensional appearance yet in such a way as to allow length, breadth and height to be measured. They are set up from orthographic projections and can be drawn to various scales. The projections most used are: Axonometric, Isometric and Oblique.

Axonometric Projection

This has the advantage of containing a true plan and is therefore more readily set up from existing drawings. It is particularly suitable for showing views of interiors.

Fig. 111 illustrates the principle. The drawings can be made most readily using a T-square and 45 degree set-square, although so long as the "plan" view remains a true plan the angle at which it is tilted to the horizontal on the sheet can be varied to secure the best impression. Construction lines are shown as broken lines in the two smaller examples to make clear the setting-up. Note that circles on plan appear as true circles in the axonometric, but that circles in elevation appear as ellipses, and in setting up such shapes it is necessary to enclose them in a rectangular framework of straight lines.

Fig. 112 shows the stool previously shown in orthographic projection in Fig. 71 in axonometric views looking up and down.

Many other examples of axonometric projection will be found throughout this book.

Isometric Projection

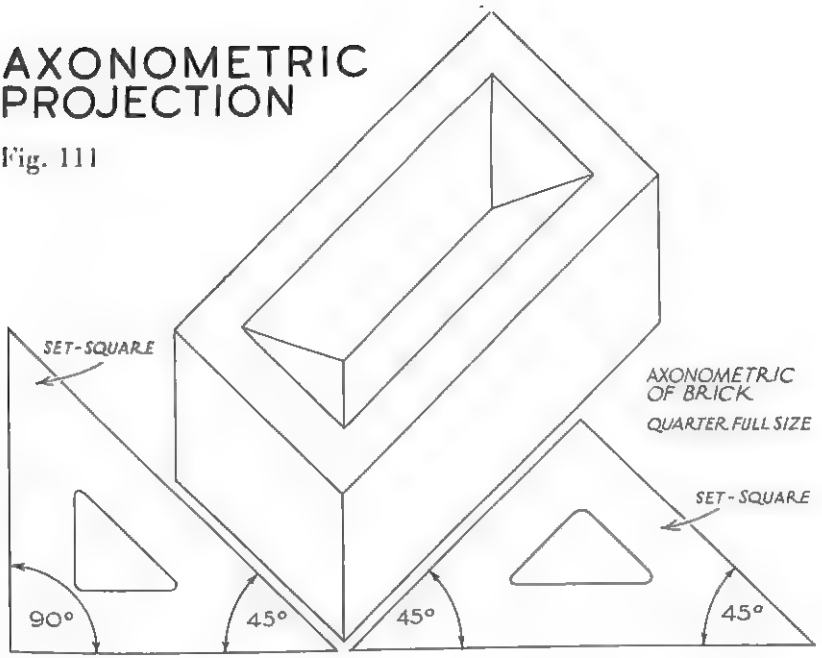
This is similar to axonometric projection, but the plan view is distorted. However, for certain shapes a realistic effect results.

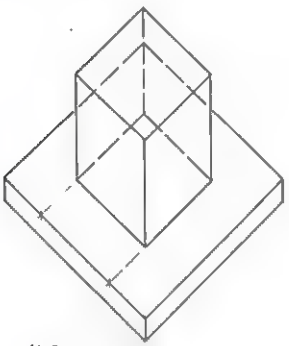
Fig. 113 shows the principle. The drawing is made with T-square and 30 degree set-square. Circles appear as ellipses both in plan and elevational views, and have to be plotted as described above.

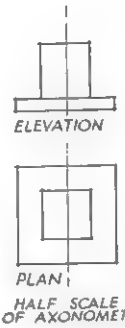
Fig. 114 shows a drawing which illustrates the value of isometric projection as a means of showing the nature of a design more clearly than can be expressed by orthographic projection only.

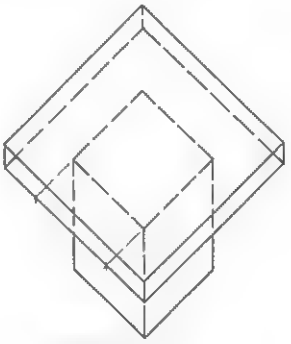
AXONOMETRIC PROJECTION

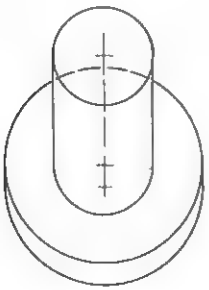
Fig. 111

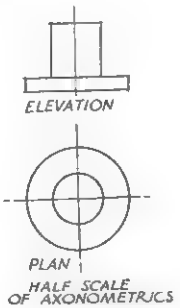


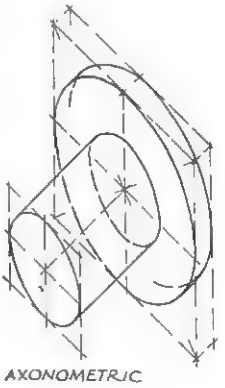












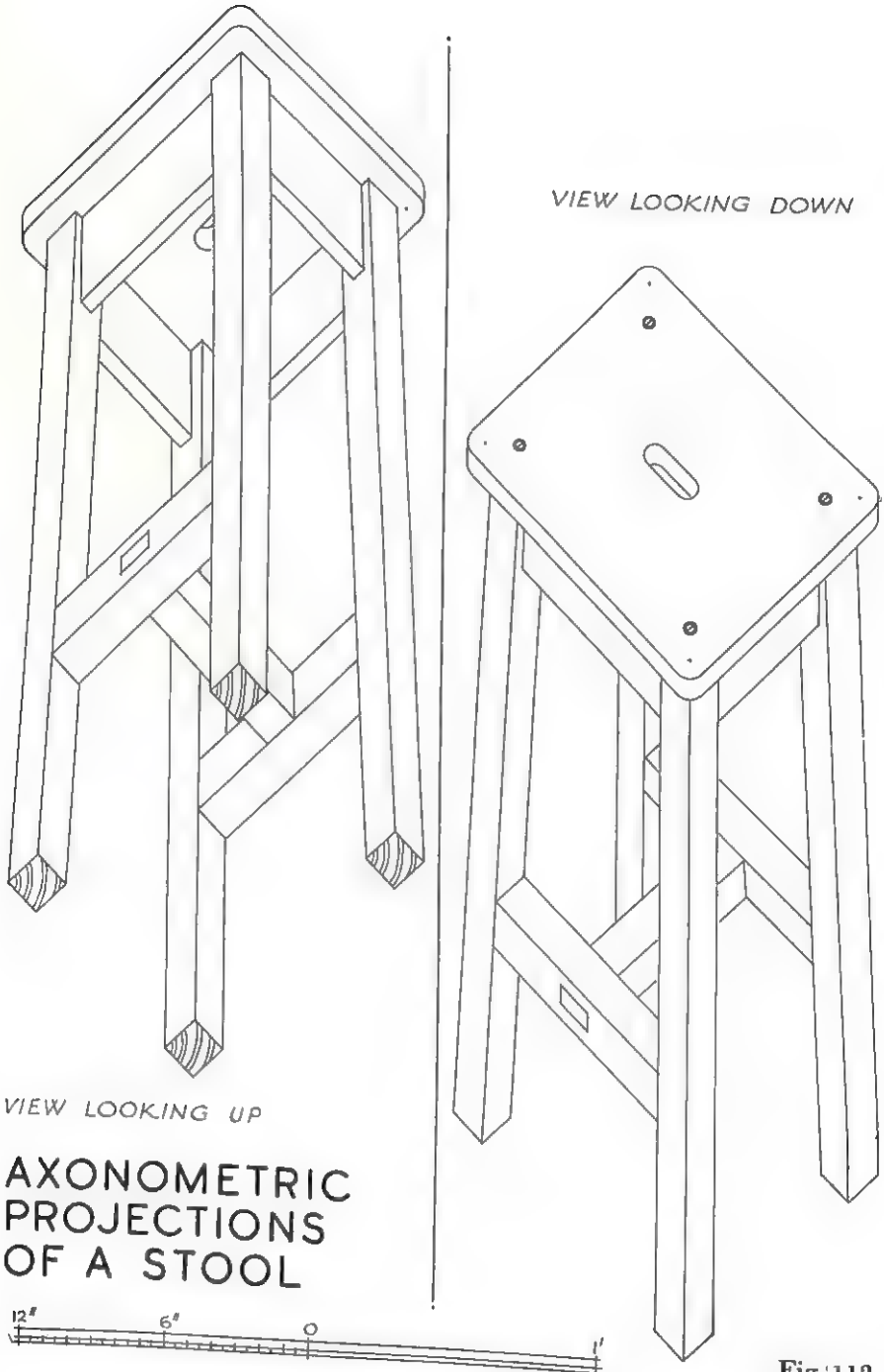

VIEW LOOKING DOWN
VIEW LOOKING UP
AXONOMETRIC
PROJECTIONS
OF A STOOL
12"
6"
0
1'

Fig. 112

ISOMETRIC PROJECTION

Fig. 113

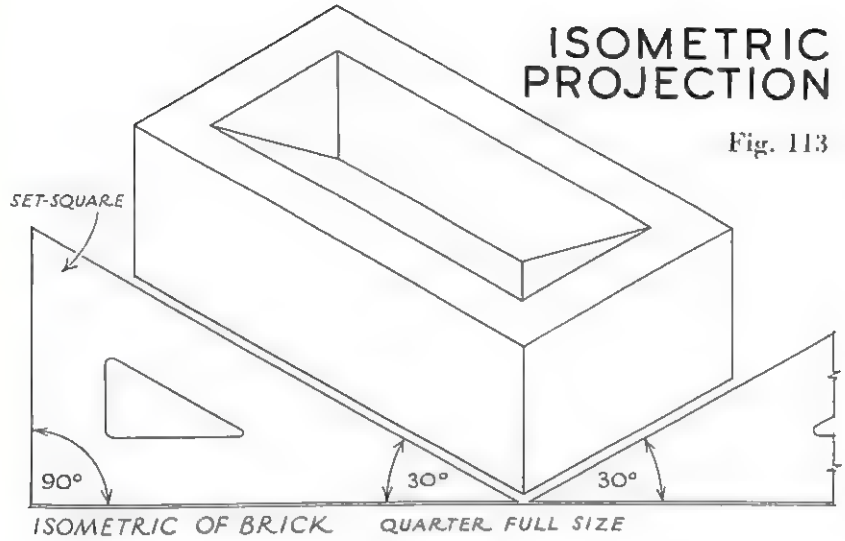
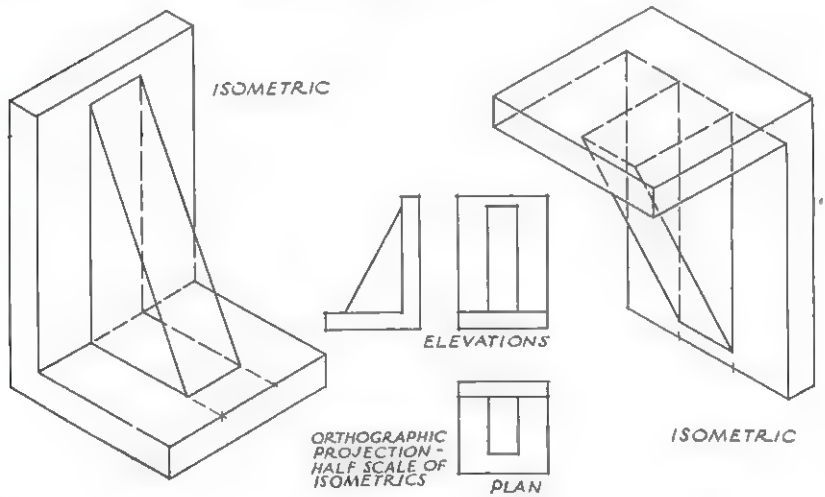
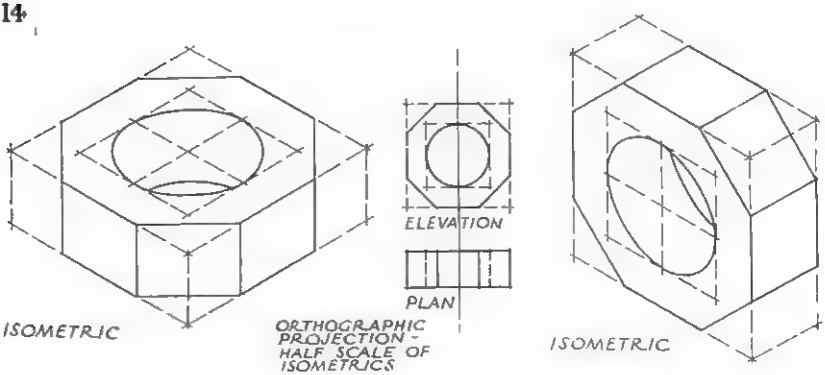


Fig. 114





Oblique Projection

The principle is illustrated by the drawings in Fig. 115. There are two variations of the method: (1) the oblique lines are drawn at 45 degrees to the horizontal and distances along them are at half the scale of that used for the horizontal and vertical lines; (2) the oblique lines are drawn at 30 degrees to the horizontal and the same scale is used for oblique, horizontal and vertical lines.

Oblique projection is used chiefly for constructional details and diagrammatic representations of buildings where the front elevation is of particular importance.

Perspective Projection

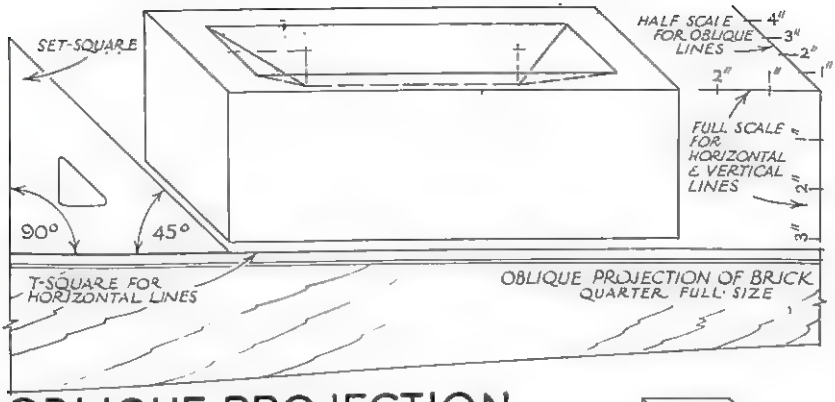
Perspective drawings are amongst the most important of design drawings as they convey more or less the actual appearance of the building or object, and are therefore of considerable value in enabling laymen to appreciate points of design which are not easily understood by them from orthographic projections.

There are a number of ways of setting up perspectives and the underlying theories are complex and can only be described in words at great length. The best way to learn to make perspectives, however, is to study the essential principles from examples and then to practice their application.

What is probably the most satisfactory method for general use is illustrated in Figs. 116 to 120.

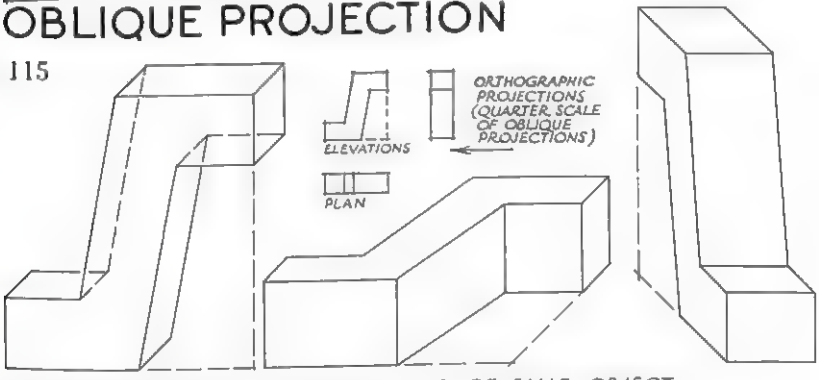
Fig. 116 shows in orthographic projection the plan and two adjacent elevations of a rectangular prism or block, and how it is set up in perspective to give a view such as would be obtained by looking obliquely at the block from a level slightly above it.

The first step is to draw the plan of the block. Then the position of the "eye" of the spectator, point S, in relation to the plan according to the view required must be decided. The position is a matter of judgment in the light of experience, but a little imagination will help the beginner to get it somewhere near where it is wanted. Assuming for simplification that the spectator is looking directly at the near corner of the block, a line is drawn from S through this corner. This line is the *direct line of vision*, and somewhere along its length another line to represent the *picture plane* is drawn at right-angles. The picture plane is an imaginary vertical plane on to which is projected the required view—see axonometric diagram. Through the remaining corners of the block on plan further lines are drawn from S to the picture plane to locate these points in the perspective. Lines are also drawn from S parallel to the sides of the block to the picture plane. These points, VP1 and VP2,

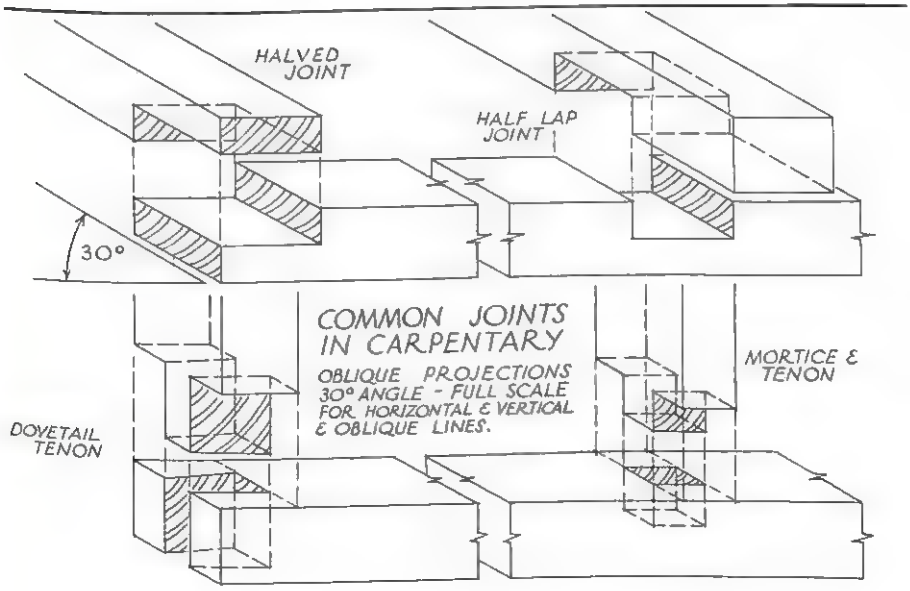


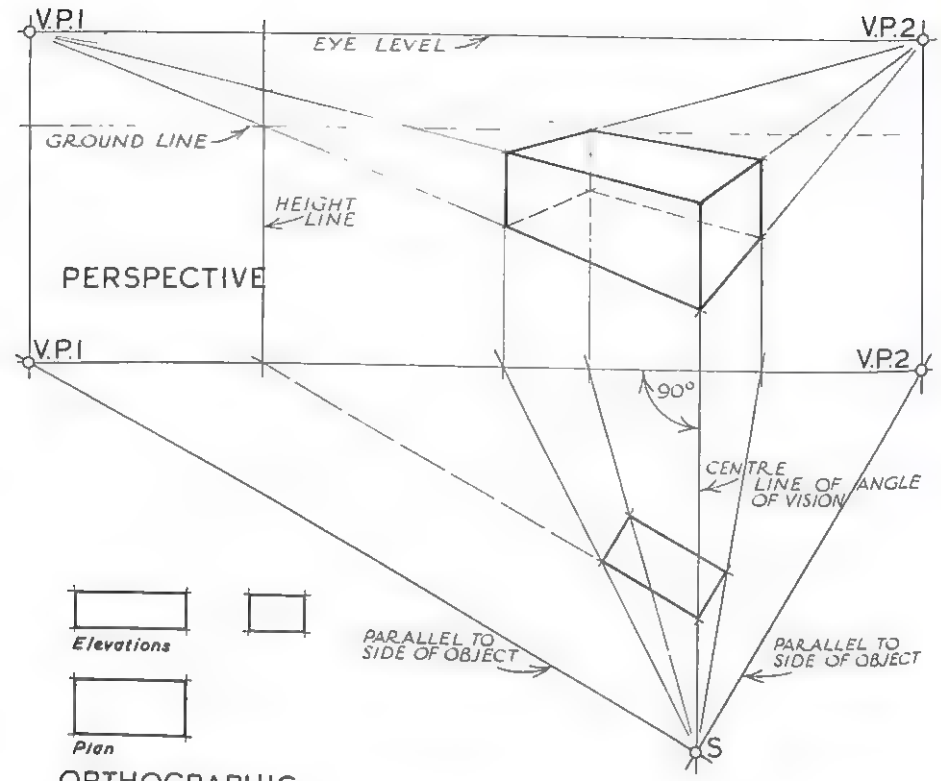
OBLIQUE PROJECTION

Fig. 115



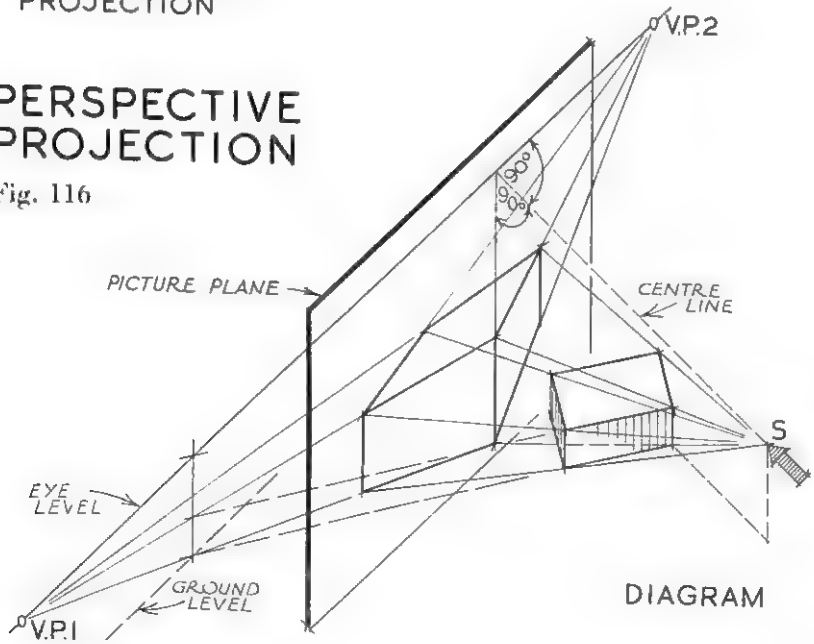
THREE DIFFERENT OBLIQUE VIEWS OF SAME OBJECT.





PERSPECTIVE PROJECTION

Fig. 116



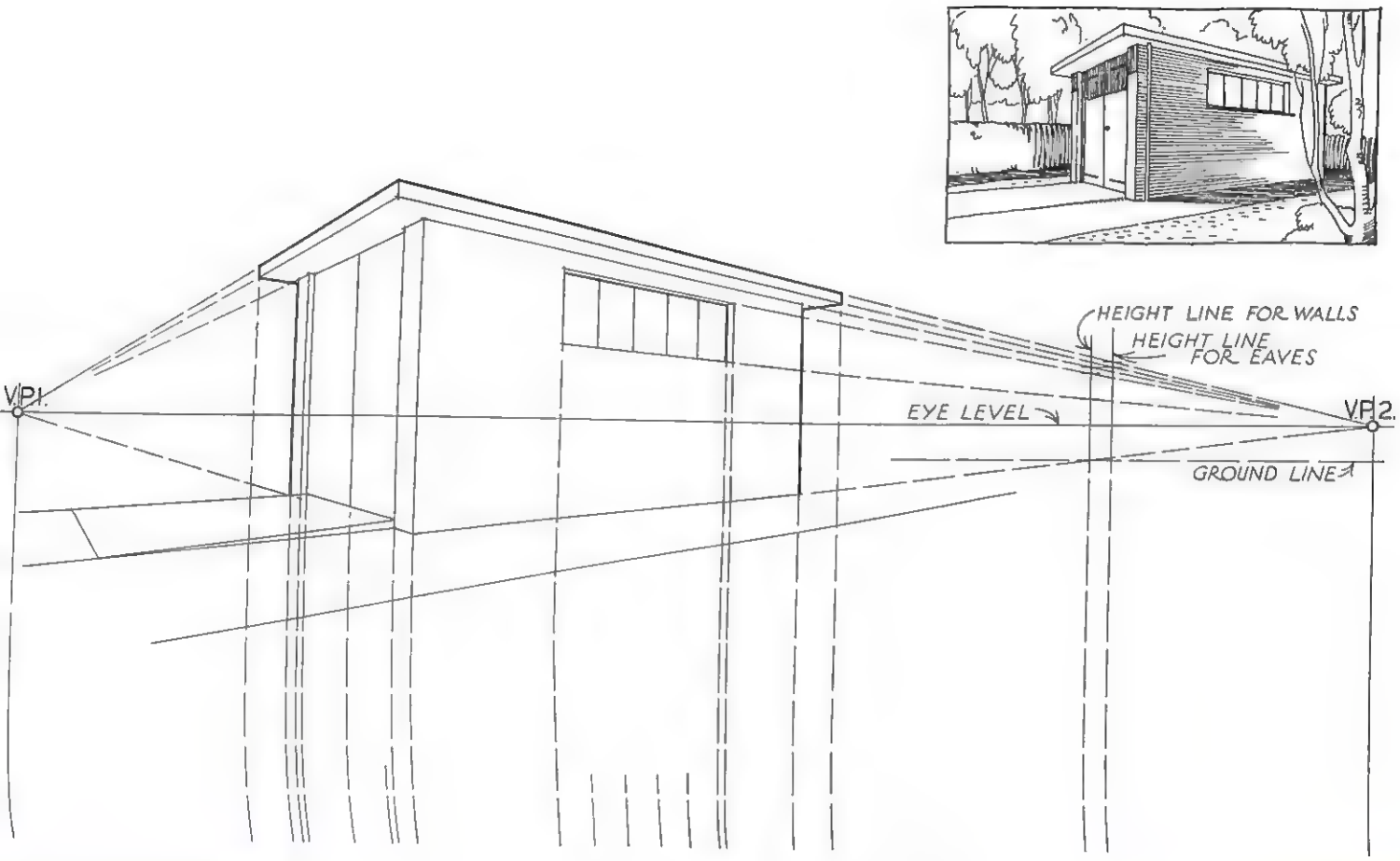
locate the positions of the vanishing points along the eye-level to which in the perspective the outlines of the sides of the block will converge. Another line is also drawn on plan in continuation of one or other side of the block to the picture plane; this line—shown broken in the figure—gives a point on the picture for the position of a *height line.*

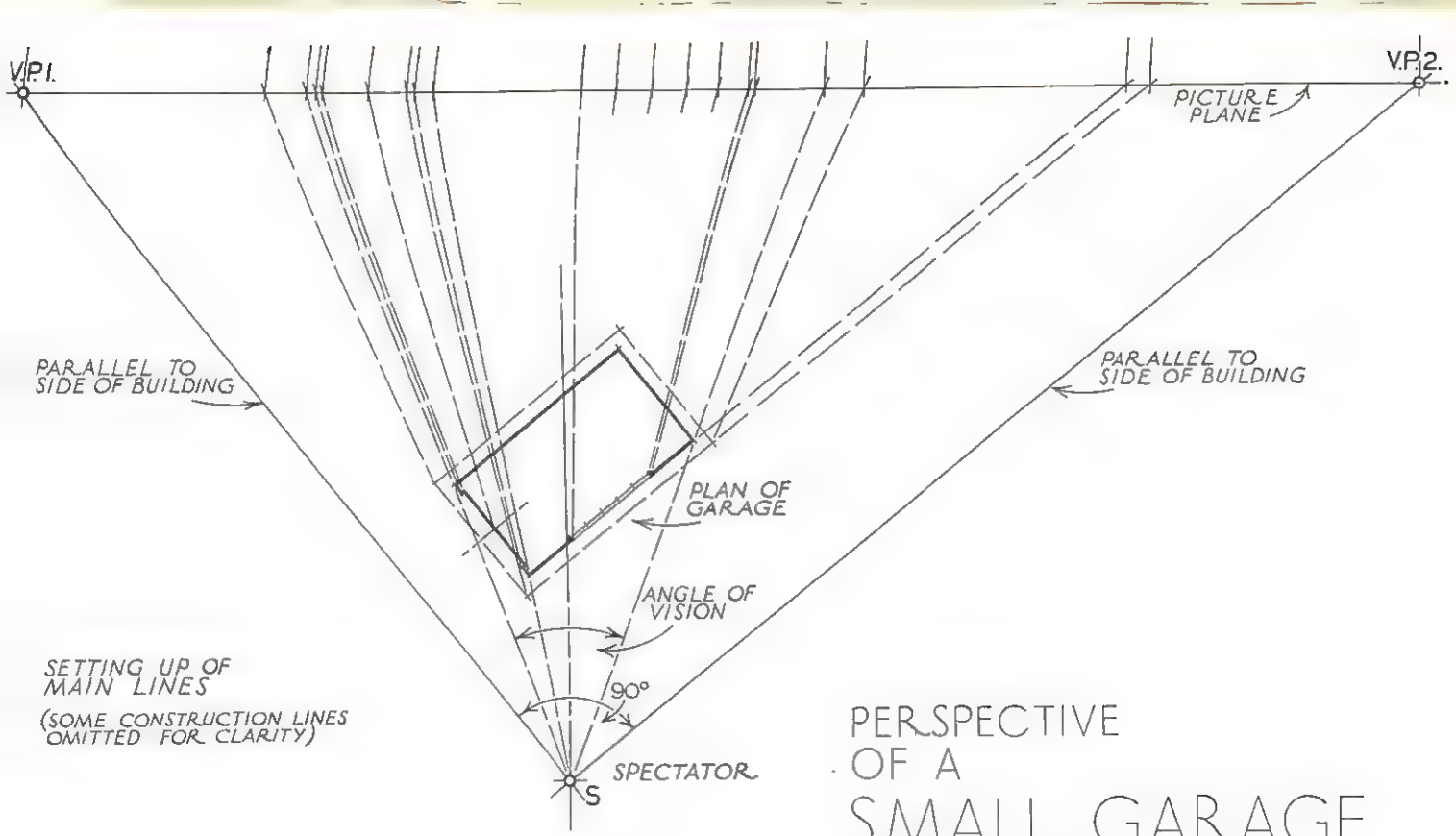
The next step is to draw the "elevation", as it were, of the picture plane, which, although shown bounded in the diagram, is actually not defined in extent. At some reasonable distance, therefore, above the plan a horizontal line is drawn; this line represents the *eye-level* of the spectator, and to it are projected perpendiculars from the picture plane on plan from VP1 and VP2 and the point for the height line. As the view required is one looking down on the block, then a point must be marked down the height line from the eye-level equal to the estimated position of the eye above the "ground" or horizontal plane on which the block rests. Through this point a horizontal line is drawn and is called the *ground line.* Up the height line from the ground line is measured the height of the block taken from the elevation, i.e. at the same scale as the plan of the block. Through the point obtained and from the intersection of ground line and height line, lines are drawn from VP1 to contact the direct line of vision continued from the plan. From the points of contact lines are drawn to VP2, and then by projecting up from the picture plane on plan it will be seen how the outline of the block in perspective is obtained.

Fig. 117 shows the application of the same method to the making of a perspective of the small garage shown in orthographic projection in Fig. 72. Most of the construction lines are shown. In drawing the plan of the garage it is only necessary to show in detail the outside lines of the two sides which will appear in the perspective, but care must always be taken that every salient feature is indicated. Note the broken line representing the projecting eaves of the roof.

The direct line of vision should preferably not pass through the near corner of the building and never so as to bisect it or the effect will be spoiled. A good way of fixing its position is to draw lines from S to the limits of the building, or wider if it is proposed to include much of the surroundings in the picture; the angle formed by these lines, termed the *angle of vision* and which should be between 40 and 60 degrees to correspond to the normal range, is then bisected to find the direct line of vision.

The picture plane must always be at right-angles to the line of vision, and the angle between the lines drawn to locate the vanishing points must also be a right-angle.


HEIGHT LINE FOR WALLS
HEIGHT LINE FOR EAVES
VP1.
EYE LEVEL
VP2.
GROUND LINE



PERSPECTIVE OF A SMALL GARAGE

Fig. 117

In the perspective of the garage the eye-level has been taken at a height of 3 feet above ground level. "Normal" eye-level can be regarded as about 5 feet above ground level, but somewhat lower than this is better for small buildings.

Note that two height lines have been taken, one for wall heights and details in the same planes, and one for the eaves. As many height lines as convenient for the location of such features as chimney stacks, dormers, etc., may be taken, but the fewer the better. With practice it will be found that there are many "short cuts" once the principal lines have been established.

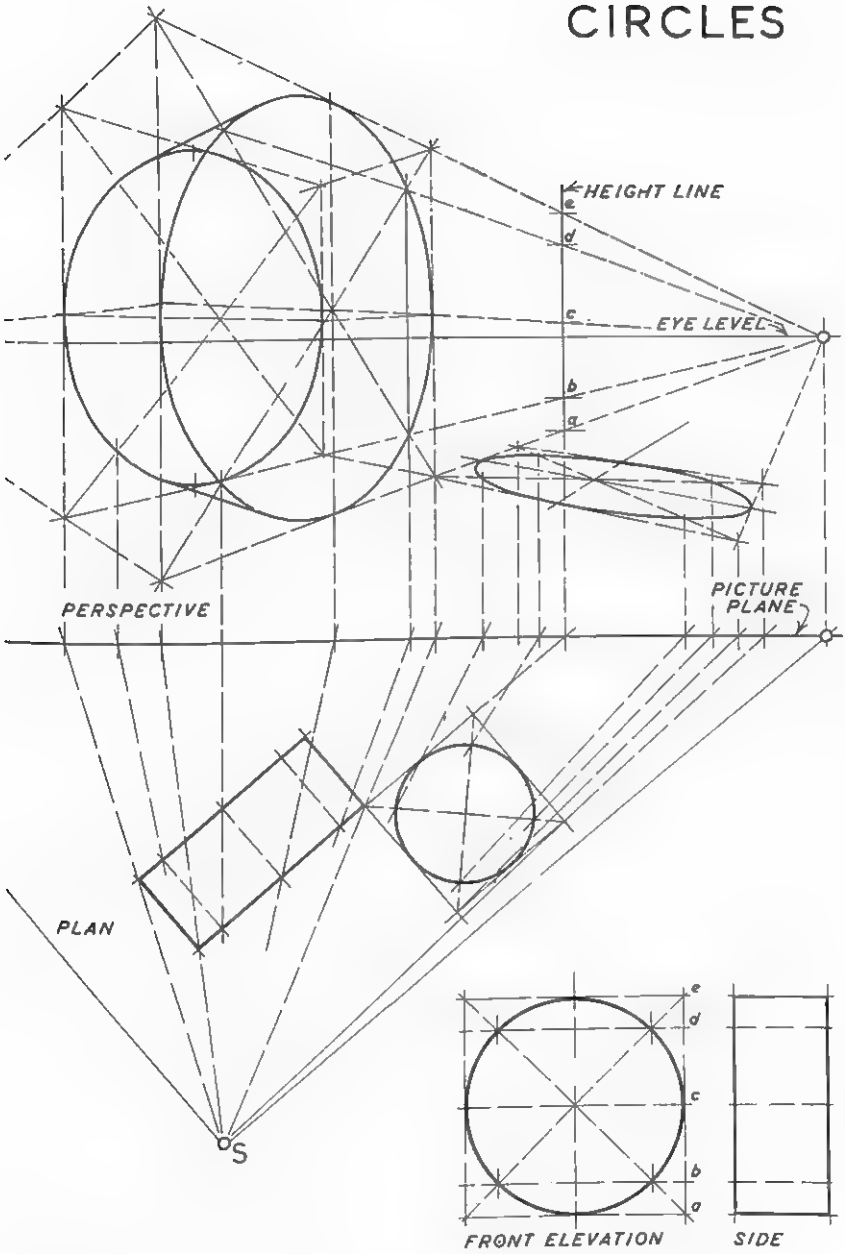
Fig. 118 shows the plotting of circles in perspective. It is necessary to enclose them in a framework of straight lines, to set up the framework in perspective and then draw the curves through located points on the framework. Incidentally, circles on plan tend to become distorted in perspective and better results can be obtained by drawing ellipses or part ellipses by eye once the general positions of the curves have been plotted.

In many other ways, too, it will be discovered that details can often be approximated in perspective by eye with far more satisfactory results than by a rigid adherence to the mechanical method of setting-up, as no method is completely free from distortion. And generally, apart from exercises in the subject, the aim of perspective drawing is to give as true a picture of the actual building as possible. But only practice and experience can provide the knowledge which enable these improvisations to be made and the beginner should not take liberties too soon or he will probably get into a hopeless tangle.

Fig. 119 illustrates a perspective view set up by the above method of the small house shown in orthographic projection in Figs. 105 and 106.

The foregoing method of perspective projection is known as "Two-point Perspective" and is used for buildings generally. Another method of projection, which is more suitable for interior views or for the surroundings of a building seen in a straight elevation view, is known as "One-point" or "Parallel" or "Interior" perspective, and the principle is illustrated in Fig. 120.

The basis is the same as for the method already described. The diagram, Fig. 120, shows how the projection is made. In Fig. 120 (1), AD, BC, BH, FG is the plan of a room or part of a room; S is the position of the "eye" of the spectator looking directly into the room. The picture plane is taken in the same plane as the end wall of the room, i.e. plane ABCD. On plan, lines are drawn from S through the near corners of the room, EH and FG, to contact the picture plane. The elevation of the



PERSPECTIVE PROJECTION

Fig. 118

Fig. 119

end wall, ABCD, is now drawn to scale immediately above the plan, and the height of the eye-level is determined and a horizontal line accordingly drawn across it. Where the direct line of vision continued up from the plan cuts the eye-level is the vanishing point VP1 for all "lines" running parallel to the direct line of vision. Therefore by drawing lines from VP1 through A, B, C and D to contact the projection of EH and FG to the picture plane, the sides, floor and ceiling of the room in perspective are located.

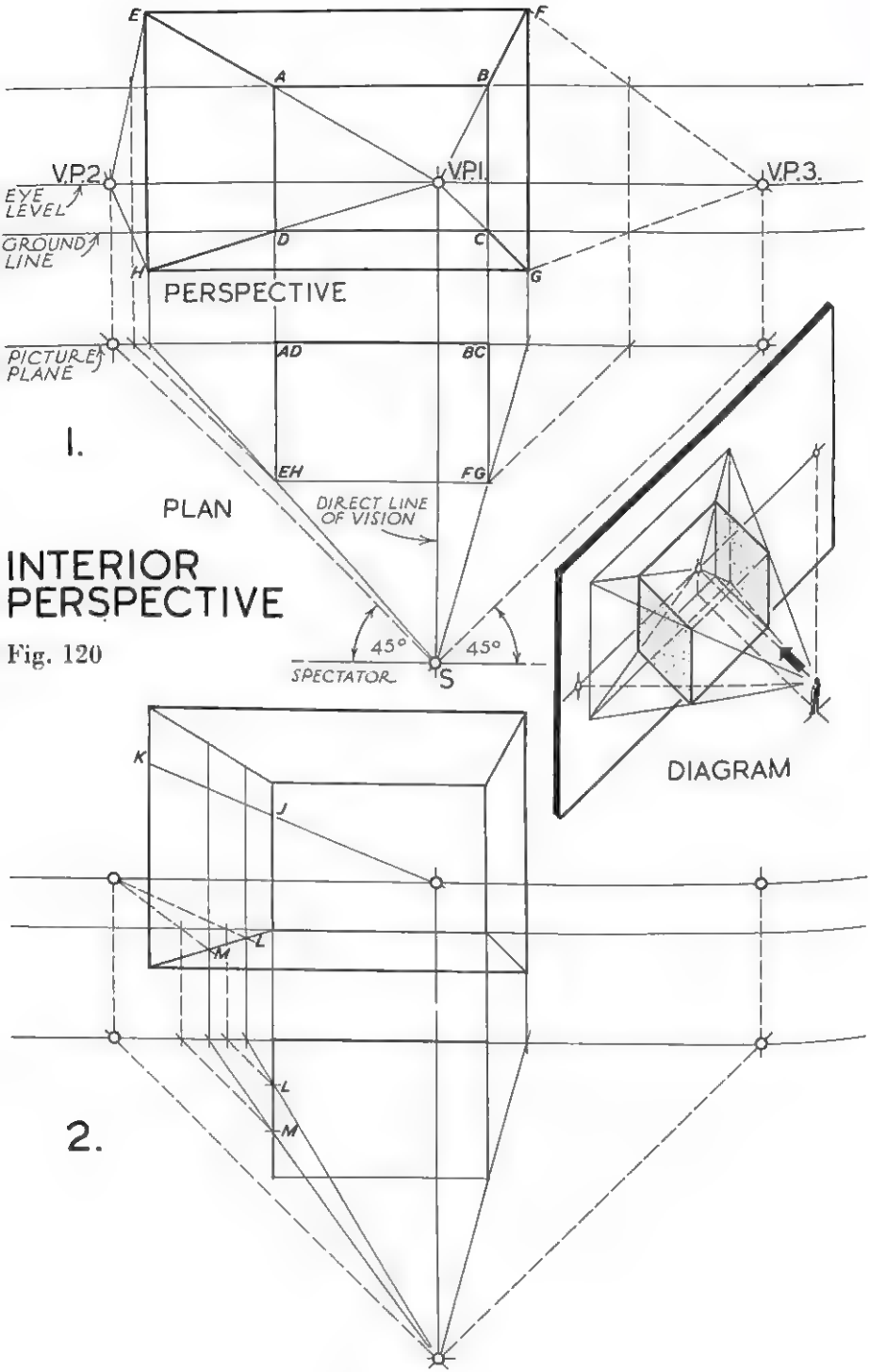
Fig. 120 (2) shows how vertical and horizontal lines on the side walls are drawn. On plan, points L and M represent vertical "lines" on the left-hand wall of the room, e.g. mullions, panelling, etc. By drawing through these points from S and projecting perpendiculars upwards, the lines can be drawn in the correct positions on the side wall in perspective. KJ is a horizontal "line" on the same wall; the height of it above the floor or the distance below the ceiling is known and is marked to scale along the corner of the room, AD, on the picture plane, and the line can then be drawn in perspective from VP1.

Fig. 120 (3) shows the location of two points, O and P, on the floor and ceiling respectively. Their positions are marked on the plan and lines are drawn from them at 45 degrees to the picture plane (for convenience one is taken to the left and one to the right). By reference to Fig. 120 (1) it will be seen how vanishing points, VP2 and VP3, are obtained for lines running at 45 degrees across the plan. From the point where the line on plan from O cuts the picture plane a perpendicular is projected upwards to cut the bottom line of the end wall extended; through this intersection a line is drawn from VP2 to contact a line from VP1 through the point where a perpendicular from O on plan cuts the end wall floor line, thus locating O in the perspective. Point P is found in a similar manner, the line of the ceiling level of the end wall being used in the construction.

Fig. 120 (4) shows a further stage illustrating in a similar manner the construction of, say, a book-case, QW, RU, SV, TX, projecting at right-angles from the side wall.

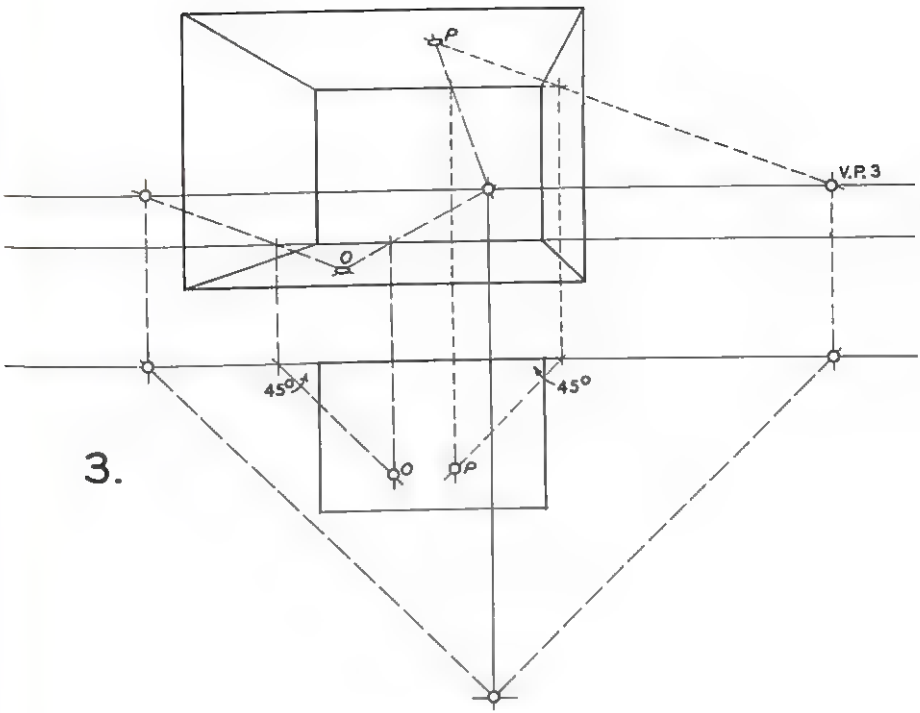
The main lines or salient points of any pattern or object within the room can be plotted by the above methods in perspective.

In all perspective drawing the construction lines should be very light, but clearly and accurately drawn. The slightest error can easily become greatly exaggerated and upset the whole working. It is sometimes advisable to index points and lines on plan with letter or figures when they are numerous or close together in order to keep track of them. Always set up the main lines of the building or object first and work progressively from large to small details.

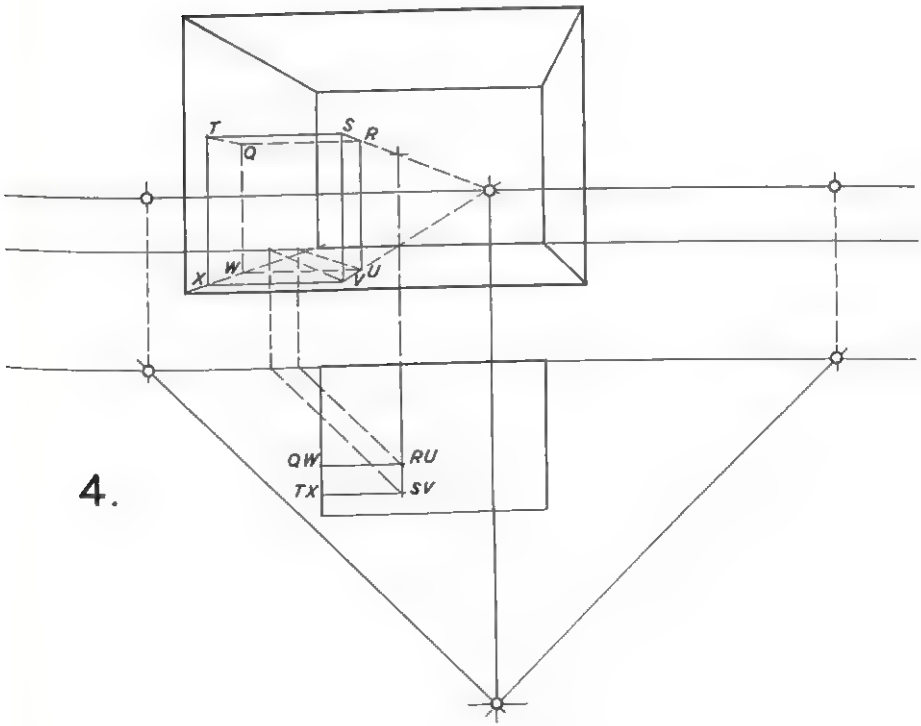


INTERIOR PERSPECTIVE

Fig. 120



3.



4.

CHAPTER VIII

RENDERING

Rendering

DESIGN drawings can be "rendered", that is, coloured or otherwise treated in a number of different ways employing various media and techniques with the object of explaining the design more clearly than is possible by a line drawing only.

One of the first aids in this respect is the showing of shades and shadows, which bring out the three-dimensional forms and the relationship of the various planes of the building or object to which they are applied.

Shadow Projection

In architectural drawings the addition of shades and shadows on buildings is made according to the convention that the sun or source of light illuminates downwards from the left-hand side at an angle of 45 degrees to the horizontal in elevation, and across at 45 degrees to the front of the building in plan.

Fig. 121 illustrates the principle by means of axonometric and orthographic drawings. The rays of light are assumed to be parallel.

The convention is a reasonable one as it corresponds to average natural conditions, and has the advantages of (1) giving shadows the width and height of which are in most cases the same as the projection or recess causing them, and (2) making the plotting easy as it can be done entirely with T-square and 45 degree set-square. There is, however, no reason why the angle should not be varied, e.g. made 60 degrees, if this would avoid confusion with other lines on the drawing, although this problem seldom arises.

Usually the projection of shades and shadows is made from elevation and plan, but sometimes it is necessary to work from elevation and section or side elevation.

The following examples illustrate the application of the principle to various geometrical solids, which are analogous to building forms. It is only by actually working out such examples that the method can be really grasped.

Fig. 122 (1) shows the shadow cast by an upright square prism (post) on horizontal (ground) and vertical (wall) planes as seen in the axonometric. Lines at 45 degrees are drawn on elevation from the top corners of the prism in the direction of the light rays, and in a similar manner from the corners of the prism on

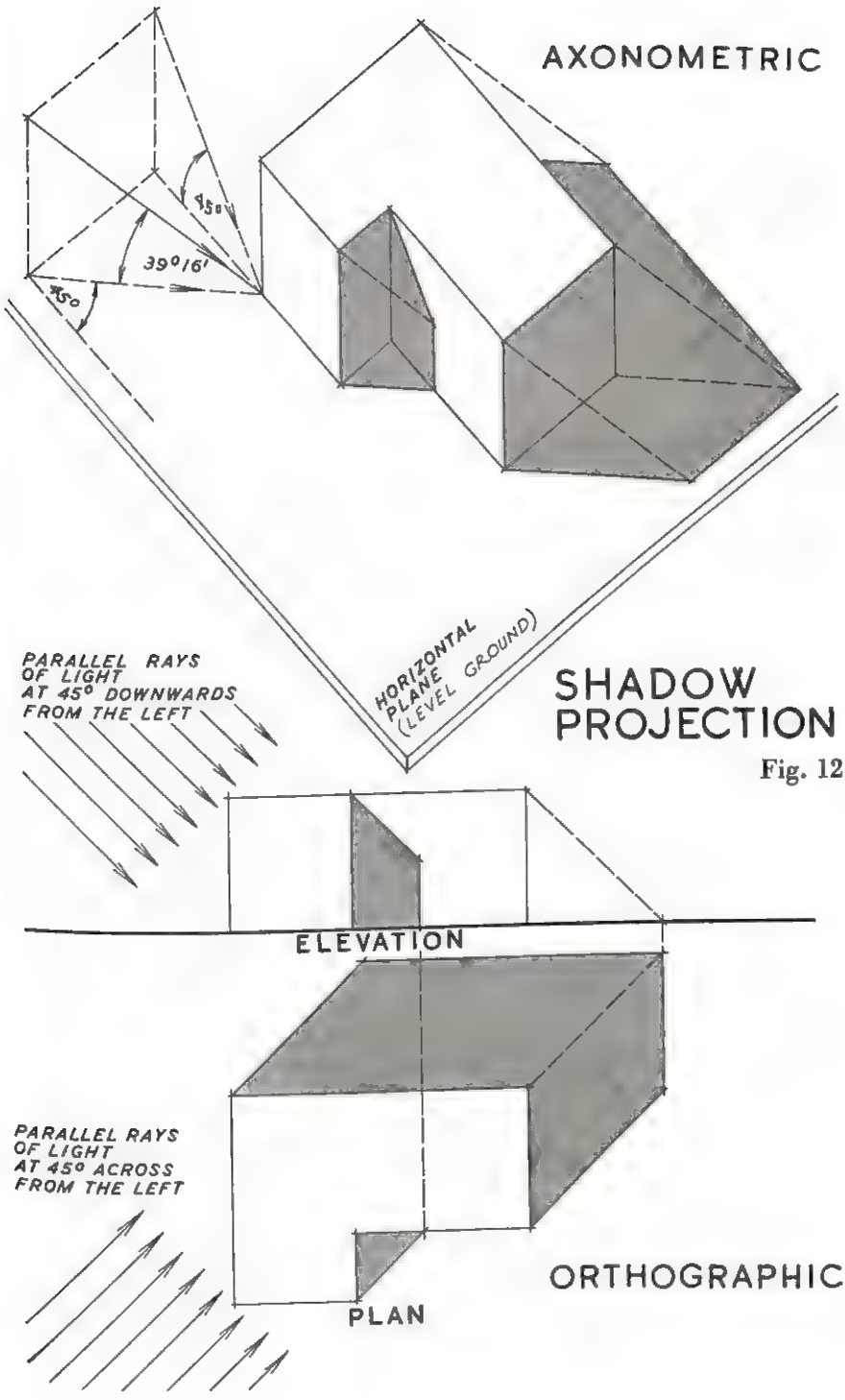

AXONOMETRIC
45°
39°16'
45°
HORIZONTAL PLANE (LEVEL GROUND)
SHADOW PROJECTION
PARALLEL RAYS OF LIGHT AT 45° DOWNWARDS FROM THE LEFT
ELEVATION
PARALLEL RAYS OF LIGHT AT 45° ACROSS FROM THE LEFT
PLAN
ORTHOGRAPHIC

Fig. 121

plan. Where the lines on plan contact the vertical plane, perpendiculars are projected up to intersect the lines drawn on elevation and thus the outlines of the shadow are plotted. The various points are indexed on the drawing for clarity. If the prism had been far enough in front of the vertical plane its shadow would have fallen wholly on the horizontal plane. Its position would be found by projecting perpendiculars down from the points on the horizontal plane in elevation cut by the 45 degree lines from the top of the prism.

The sides of the prism away from the light source are in shade. The difference between shade and shadow is: *shade* occurs on a surface when because of its position in relation to the direction of the rays of light, it receives diminished light or no light at all; and *shadow* is that part of a surface receiving no direct light because some object comes between it and the source of light.

Fig. 122 (2) shows the casting of the shadow of an upright cylinder in a position similar to that of the prism. The shadow outline of the top has to be found by enclosing it in a square, by plotting the square in shadow and then through the common points of square and circle by drawing a smooth free-hand curve, actually an ellipse. Part of the shade of the cylinder appears in the elevation. This is found by projecting up from the tangent point where a 45 degree line touches the circle representing the cylinder on plan. Although shown as a straight line dividing surfaces of light and dark on elevation, there would actually be no such hard division but a gradual change from the lightest part of the cylinder to the darkest. On small scale drawings, however, it is usual to rule the line and darken to the right-hand side of it.

Fig. 122 (3) shows the shadow of an octagonal prism, and Fig. 122 (4) the shadow of a cone worked out on similar lines.

Figs. 123 (1, 2 and 3) are examples of shadows cast by a square block on top of a square or rectangular prism, an octagonal prism and a cylinder. The construction lines are shown so that the plotting can be followed. Notice in regard to (1) that it is only necessary to draw down at 45 degrees from the bottom left-hand corner of the block to the left-hand side of the prism in elevation, and then to draw a horizontal line across the prism. For proof, any point, A, on the shadow-casting edge of the block can be plotted in shadow and it will be found to lie along the horizontal line. In (2) note the effect on the shadow caused by the corner of the block falling in shadow on the face of the prism which is at right-angles to the direction of the light rays. In (3), the shadow of the corner of the block is plotted on the surface of the cylinder, and a convenient number of points are likewise taken along the lower shadow-casting edge of the front

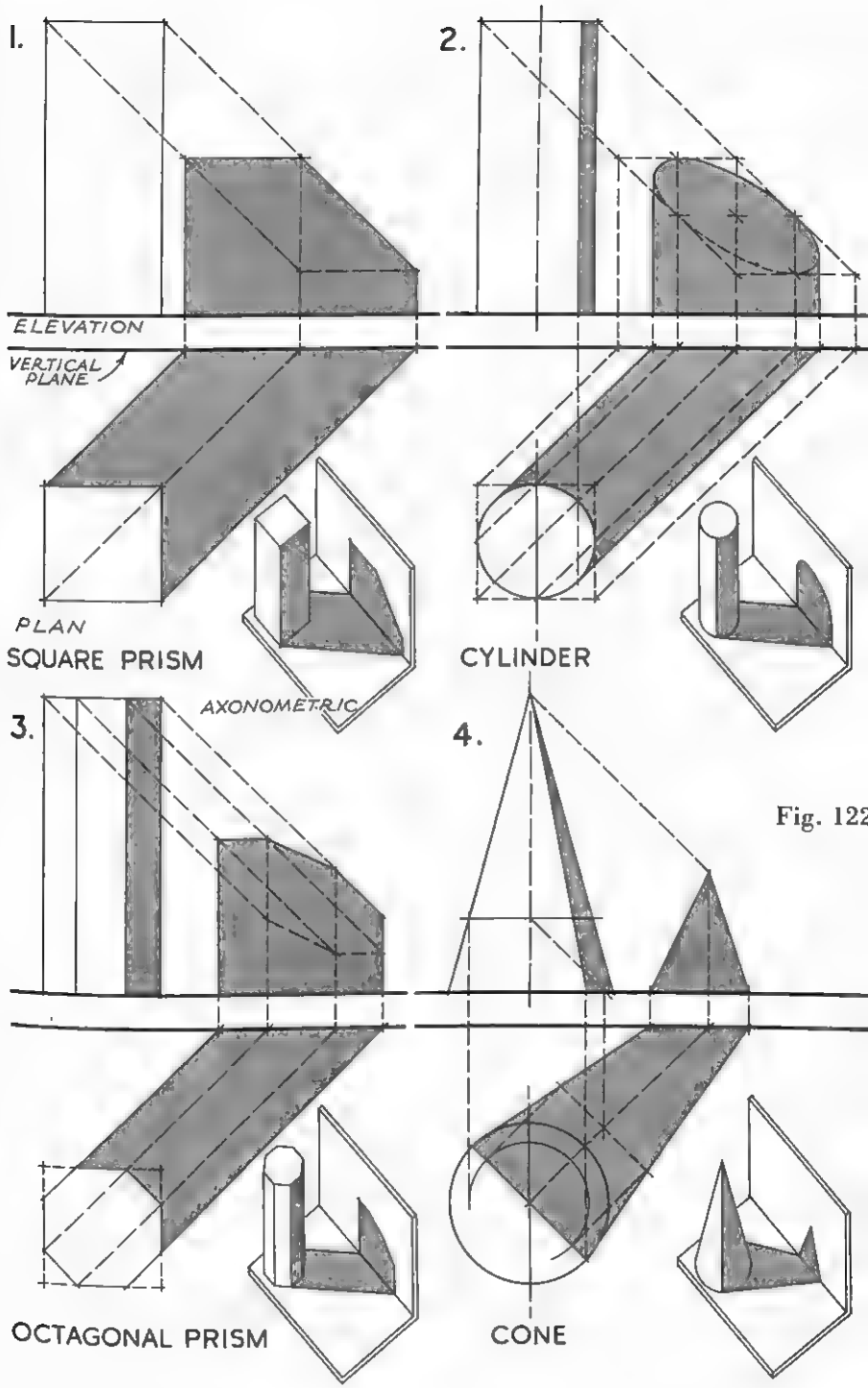

1.
2.
ELEVATION
VERTICAL PLANE
PLAN
SQUARE PRISM
AXONOMETRIC
CYLINDER
3.
4.
OCTAGONAL PRISM
CONE

Fig. 122

of the block and are similarly plotted. A curve has then to be drawn through these points. The line of the shadow cast by the lower left-hand return edge of the block appears as a straight line at 45 degrees in elevation. This can be proved by casting the shadows of any number of points on the edge on to the cylinder. *The shadow cast by any straight edge projecting out at right-angles to the vertical plane and parallel to the horizontal plane always appears as a 45 degree line on elevation no matter how curved or broken the surface on which it falls.* The shadow merges on the right with the shade of the cylinder. As previously mentioned, the shade is not really defined by a hard edge but gradually fades into the lighter portion of the surface.

Figs. 23 (4, 5 and 6), similar to the foregoing, show the shadows cast by circular blocks on top of a square or rectangular prism, an octagonal prism and a cylinder. In each case it is necessary to plot the shadow from a number of points taken along the shadow-casting edge.

Fig. 124 illustrates examples of shadows cast by projections at right-angles to a surface (vertical plane) in elevation. These are the equivalents of the shadows cast by similar vertical solids as would be seen on plan, although the direction of the shadows in relation to the objects would then be the same as the direction of the light rays. The construction lines are shown as before. Note that the end of the cylinder appears as a circle in shadow and can be most easily drawn by plotting the centre.

Fig. 125 shows examples of shadows formed in recesses. The shadows are cast by the left-hand edge in each case. The simplest way to find the shadow in the circular recess is to plot the centre of the front edge of the recess as shown. The curve of the shadow in plan in this example cannot be plotted except at a very large scale; it is sufficient to plot its beginning from the 45 degree tangent to the recess on elevation and to draw back a flat curve to the point where the shadow on elevation begins.

In Fig. 126 are illustrated two typical examples of shadows cast by buildings with pitched roofs. It will be seen that if the pitch of the roof is less than 45 degrees there is no shadow cast by any part of it.

Fig. 127 shows the shadow cast by a chimney stack on a pitched roof. The plotting is similar in principle to the previous examples in Fig. 122, but it is necessary to draw the section in order to find the positions where the projectors from the top of the stack strike the inclined surface. The procedure is to find the shadow on elevation from the elevation and section, and then to project down to find the shadow on plan. Note that on elevation the inclination of the shadow lines of the vertical corners of the stack is the same as the pitch of the roof.

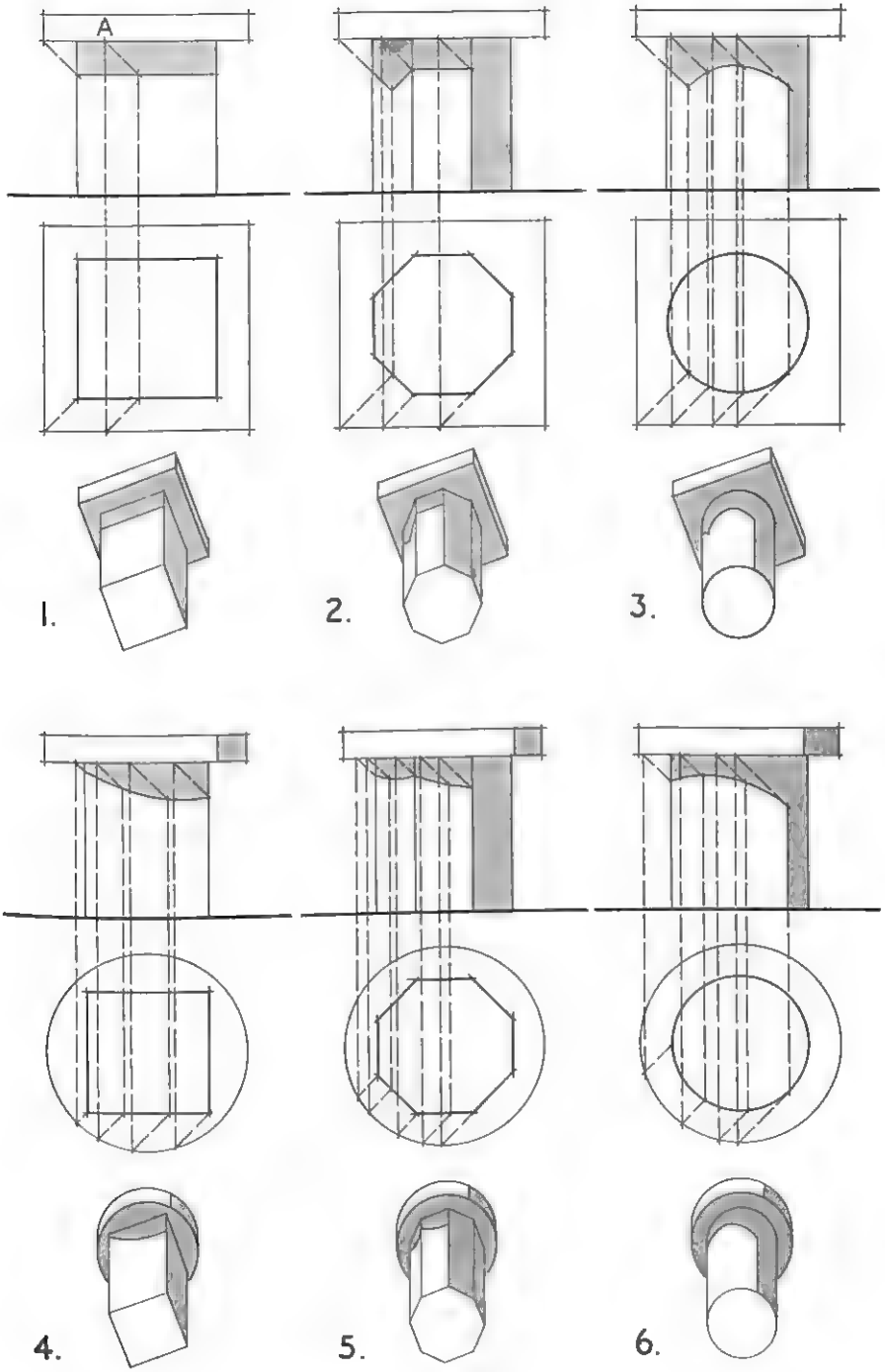
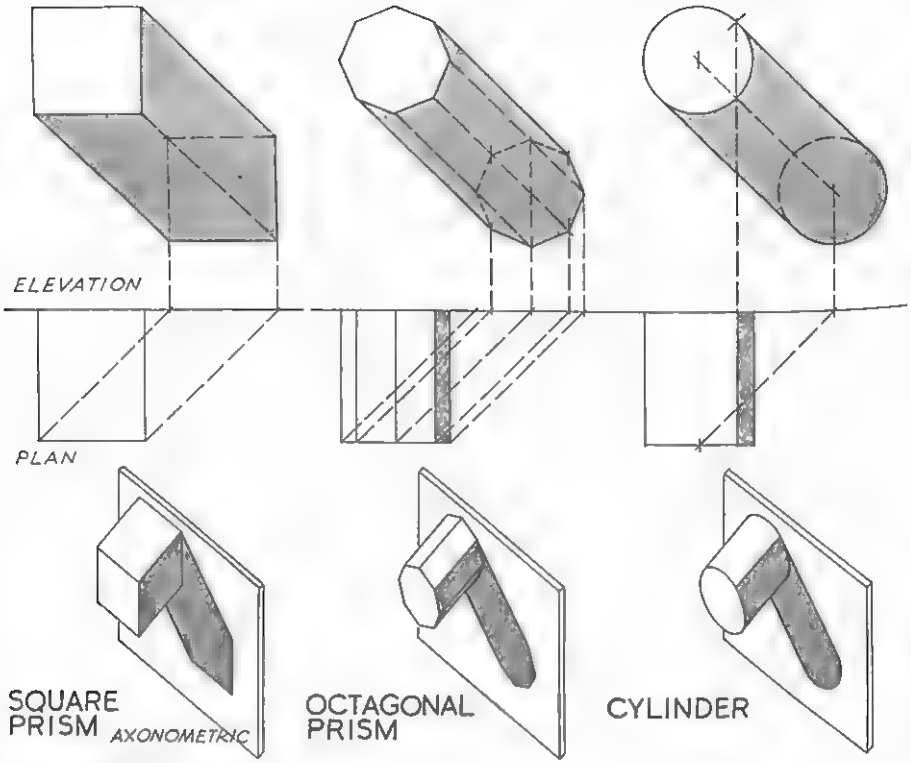
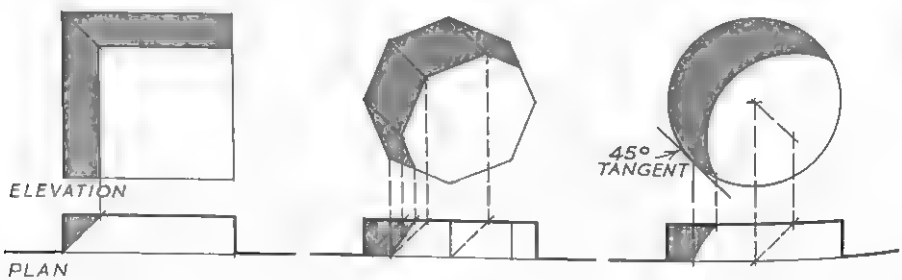


Fig. 123



PROJECTIONS

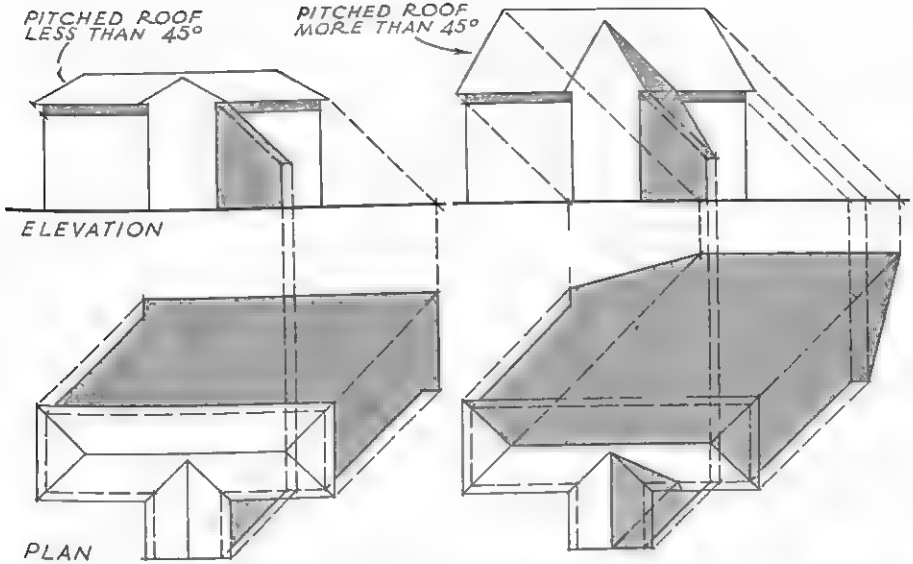
Fig. 124



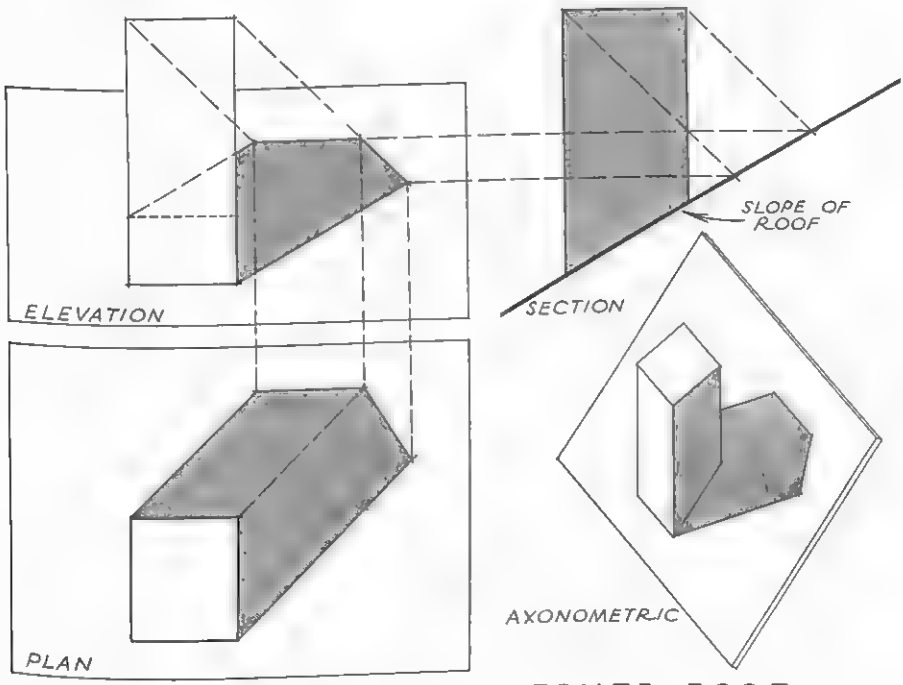
RECESSES

Fig. 125

EXAMPLES OF SHADOW PROJECTION



BUILDINGS WITH PITCHED ROOFS Fig. 126



CHIMNEY STACK AND PITCHED ROOF Fig. 127

Fig. 128 shows the shade on a horizontal cylinder and the shadow cast by it on the horizontal plane.

Fig. 129 shows the shade on a sphere and the shadow cast by it on the horizontal plane. The line of shade is the line of an oblique cut through the centre of the sphere at right-angles to the rays of light. The geometrical setting-out is not shown here,[1] but the line is drawn on plan and elevation. As in the case of shade on any curved surface this line merely marks the position of the change from diminished light to no light. The shadow cast by the sphere is found by plotting from convenient points on the shade line. The outline of the shadow is that of an ellipse.

The foregoing examples if drawn out and carefully studied provide a knowledge of shades and shadows sufficient to meet the normal requirements in the rendering of drawings of most buildings. Further examples of a complex nature would tend to carry the subject into the realm of an academic pastime without giving much further material help.

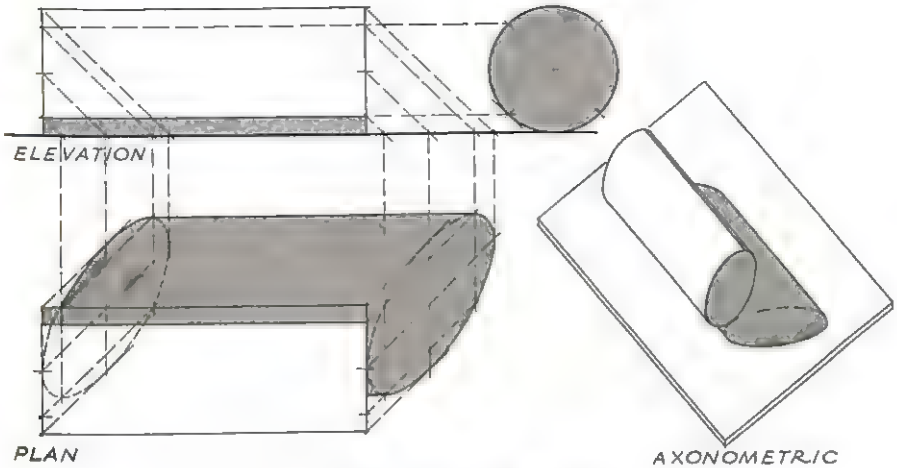
Fig. 130 shows the shadows on the elevation and plan of the small house in Fig. 105. Shadows on plan, which are often omitted, are usually taken back in the direction shown. Shadows on elevations are always shown with the sun in the same relative position to the drawing, irrespective of the actual aspects of the elevations.

Fig. 131 shows a copy of the perspective of the same house with shadows added. Shadows in perspective must be worked out in orthographic projection first and then either set up along with the rest of the perspective or added to the perspective by "eye".

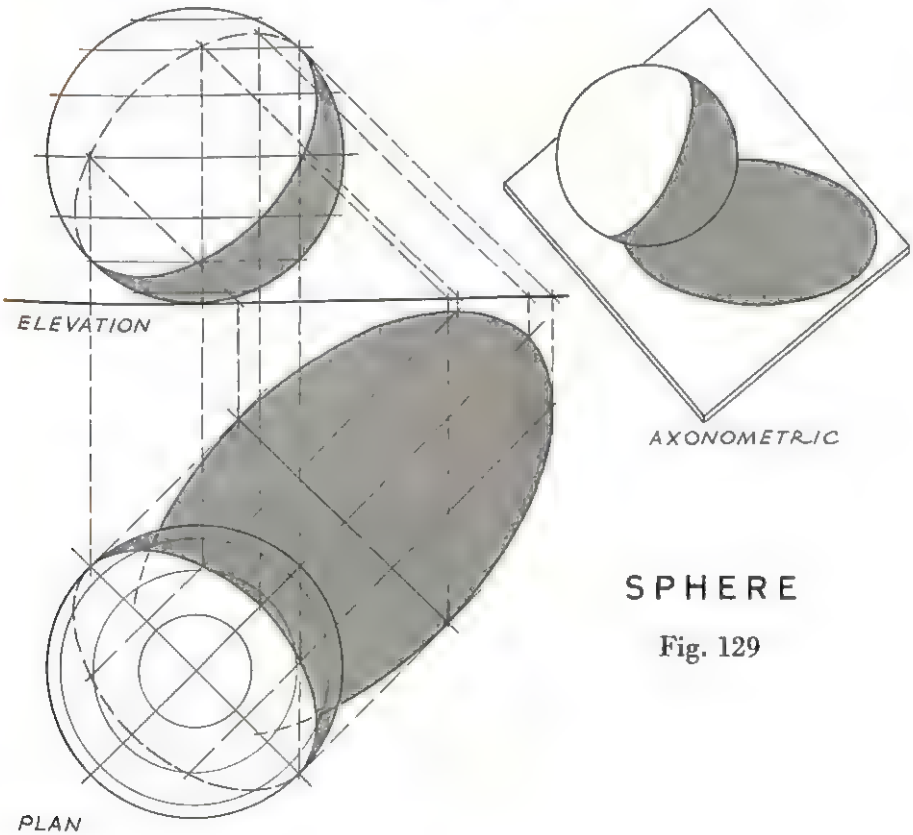
It is always better to work out shadows on tracing paper over the top of orthographic projections and then when correct to transfer them to the finished drawing. This procedure avoids spoiling the latter by the many construction lines, etc., which are necessary. Plottings should always be made with as fine a line as possible.

Outline shadows can be completed in many ways from solid blacking-in to carefully graded washes of water-colour. Sprayed, spattered or pastel shadows are often used on small scale drawings. Except where a bold effect is required, the transparency of shadows should not be lost. Shades and shadows are never really solid opaque areas, but are affected by the nature of the surfaces on which they occur and by reflected light as described below.

[1] See *Descriptive Geometry*.

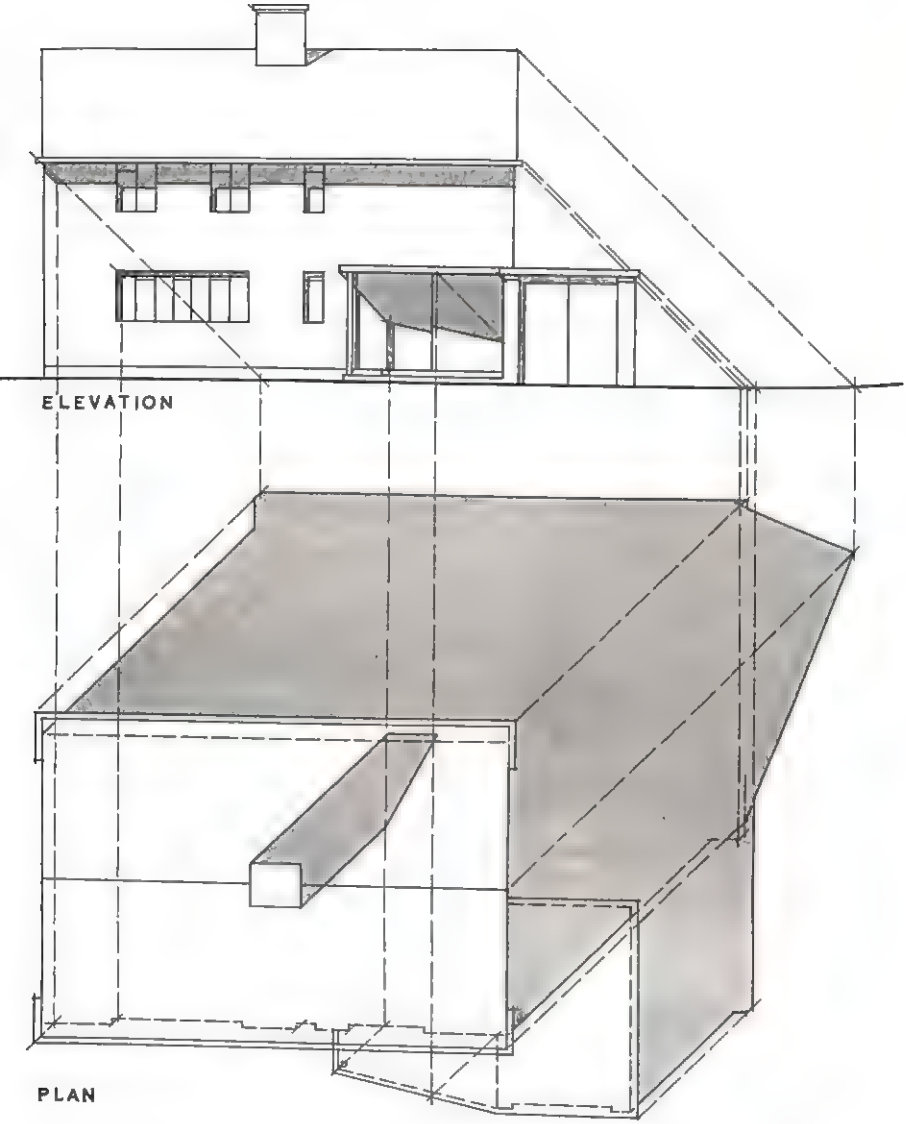


CYLINDER Fig. 128



SPHERE

Fig. 129



SHADOW PROJECTION

MAIN SHADOWS OF HOUSE SHOWN IN FIG. 105.
FOR CLARITY SOME CONSTRUCTION LINES ARE OMITTED

Fig. 130

Fig. 131

Reflected Light

Fig. 132 gives illustrations of the principle of reflected light as used in rendering and the effect it has on shades and shadows. Every surface which receives direct light rays reflects the light to some extent and according to the angle or curvature in various directions. Consequently in bright sunlight reflected light falls on some of the surfaces which are in shade or shadow and alters their intensity and even casts shadows within shadows. The reflections are actually very complex but just as there are conventional assumptions in regard to direct light so, for architectural drawings, reflected light rays are always assumed to be exactly the reverse of primary rays and to be appreciably weaker in value.

One effect of this as illustrated in Fig. 132 (1) is to vary the tones representing the shades and shadows and, instead of their being rendered one tone all over, they are graded evenly in such a way that, in general, shadows are darker along their edges or outline and shades are darker where the surface receives no direct light and least reflected light.

Fig. 132 (2) illustrates how "back shadows"—shadows within shadows—are cast by the rays of reflected light, and Fig. 132 (3) the effect of reflected light on the shadow within a deeply recessed opening.

As a general rule, no shade or shadow should be ungraded. Smooth grading helps considerably in giving "life" to a rendering, and the sharper the grading and the greater the contrast between light and dark, the stronger the effect.

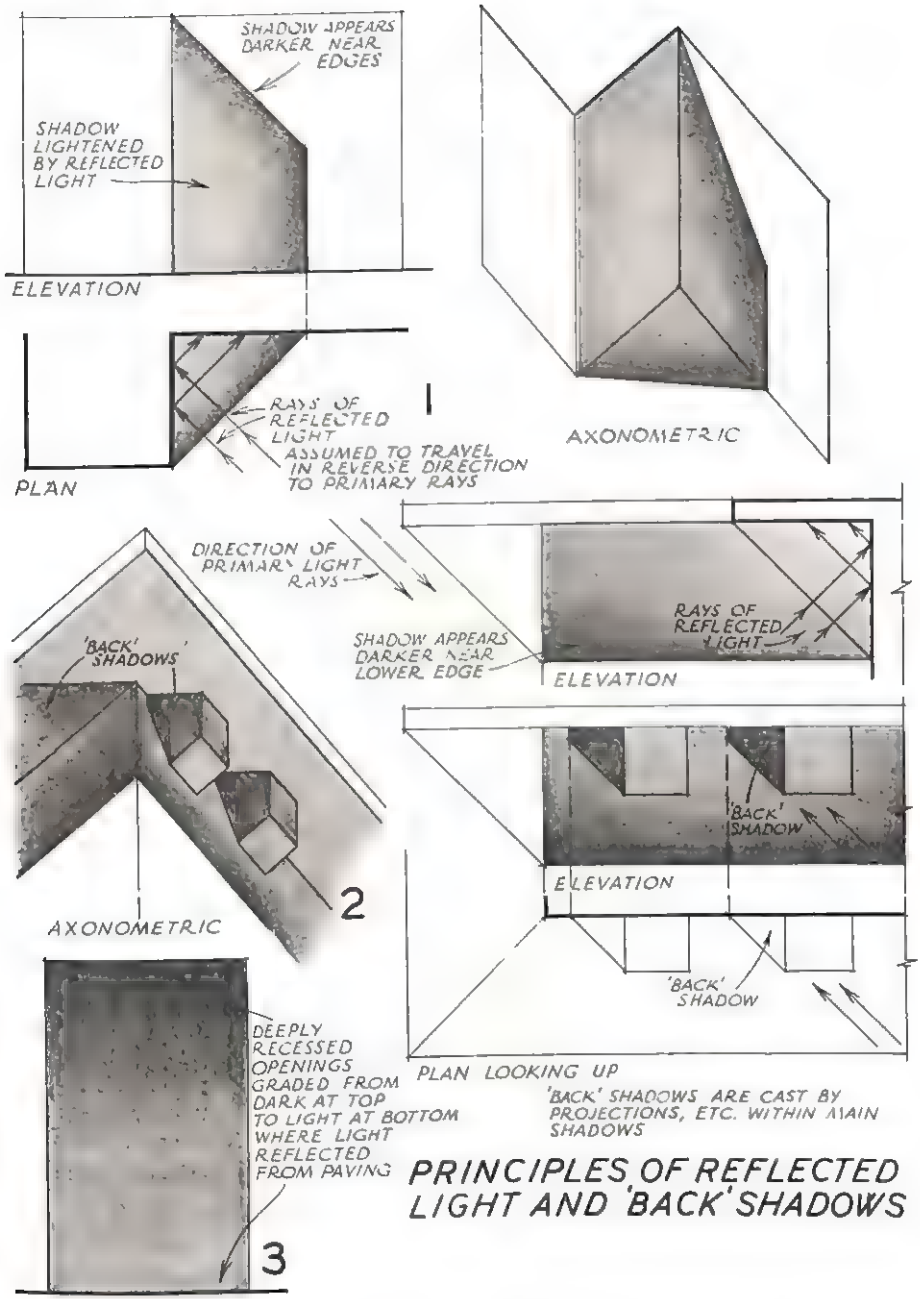
Long horizontal strips of shadow, e.g. under cornices, etc., which are too narrow to be graded with the lower edge darker can be successfully treated by making the left-hand end dark and grading off to the right.

Surroundings

The surroundings of a building, either actual or assumed, are often shown on rendered drawings to increase the realism of its presentation and to give "scale", i.e. to give an impression of the real size of the building.

To what extent this is necessary and in what manner it should be indicated, whether "conventional" or "naturalistic" for example, depends on the subject and the type of drawing desired.

The simplest treatment consists in merely putting a graded background to the elevations, generally lighter towards the ground line, like a cloudless sky.



PRINCIPLES OF REFLECTED LIGHT AND 'BACK' SHADOWS

SHADOW PROJECTION

Fig. 132

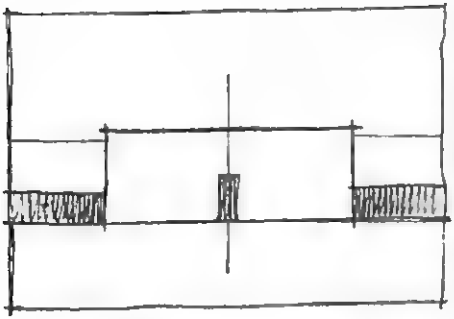
A basic conventional treatment for an isolated building is suggested by the sketches in Fig. 133. The treatment can be varied according to the technique used, scale of the drawing, etc. The first stage (1) is the putting of a dark band at the sides of the elevation to represent a hedge or fence, etc., behind it. This band, preferably graded darkest towards the building, sets it off and in conjunction with a graded sky above is quite effective. The second stage (2) shows a lighter and broader band above the first to represent a belt of trees some distance further back. Interest and probably contrast can be given to the regularity and squareness of most buildings by the addition of a tree to one side as shown in (3) and (4) and (6). A typical plan to correspond to such an arrangement is seen in (5).

The foreground is not included in the above examples, and many consider that to do so would be illogical in a purely elevational drawing, particularly if the façade of the building has any strong projections or recesses. It is fairly common, however, to show a foreground on such drawings in a semi-perspective manner as shown in Fig. 134. Sketches (1) and (2) illustrate the use of a vanishing point for converging lines of the foreground at normal eye-level on elevation. If the perspective effect is too acute with one central vanishing point, then two vanishing points equally spaced from the centre can be used, as in sketch (3).

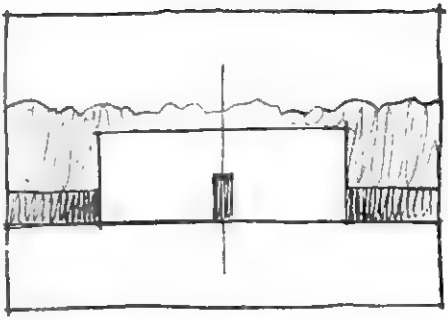
The treatment of surroundings in perspective drawings can be freer and, in general, of a more naturalistic kind than in elevational drawings. Fig. 135 shows sketches typical of perspective compositions although the possibilities and variations are limitless. Sketch (1) is an arrangement in perspective of the surroundings shown in Fig. 135 (3). The eye-level is more or less normal. Sketch (2), in which the eye-level is lower than normal, and therefore the amount of foreground should not be great, shows a composition for broader and more spacious effect with an interesting sky and view of distant landscape. Sketch (3) shows a building seen in aerial perspective. Careful attention must be paid here to the treatment of the ground, which receives greater prominence. Trees must be drawn correctly having regard to the view-point, and shadows are important elements in the composition.

Sky and Clouds

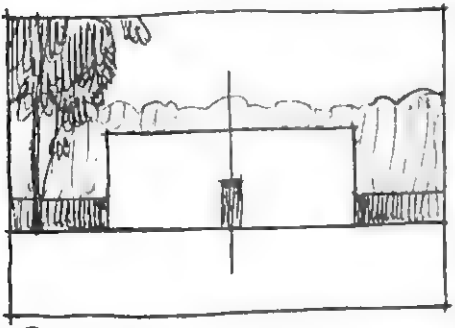
A well-rendered sky greatly enhances the appearance of a good design, even if it will not wholly compensate for a poor design. The execution is, however, difficult at first and requires study and practice.



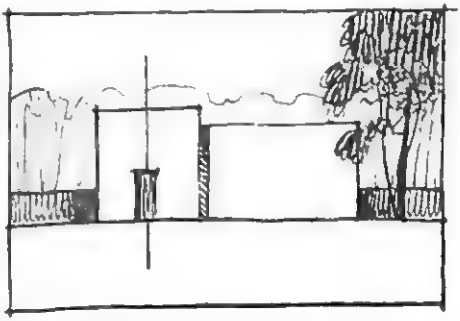
1. DARK BAND AT SIDE OF BUILDING TO REPRESENT HEDGE OR FENCE



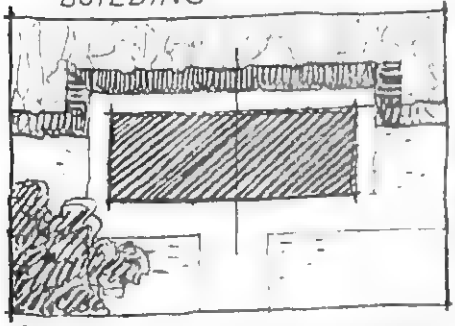
2. ADDITION OF BROAD, LIGHT BAND TO REPRESENT BELT OF TREES BEHIND BUILDING



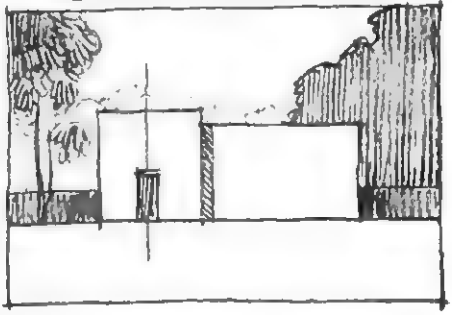
3. ADDITION OF TREE TO ONE SIDE ADDS INTEREST & GIVES CONTRAST TO BUILDING



4 APPLICATION OF 3. TO ASYMMETRICAL ELEVATION - POSITION AS REQUIRED FOR BALANCE.



5. TYPICAL PLAN REPRESENTATION OF 3. ABOVE



6. ALTERNATIVE ARRANGEMENT TO 4., ABOVE USING MASS OF DARK FOLIAGE

SURROUNDINGS *ELEVATIONS*

Fig. 133

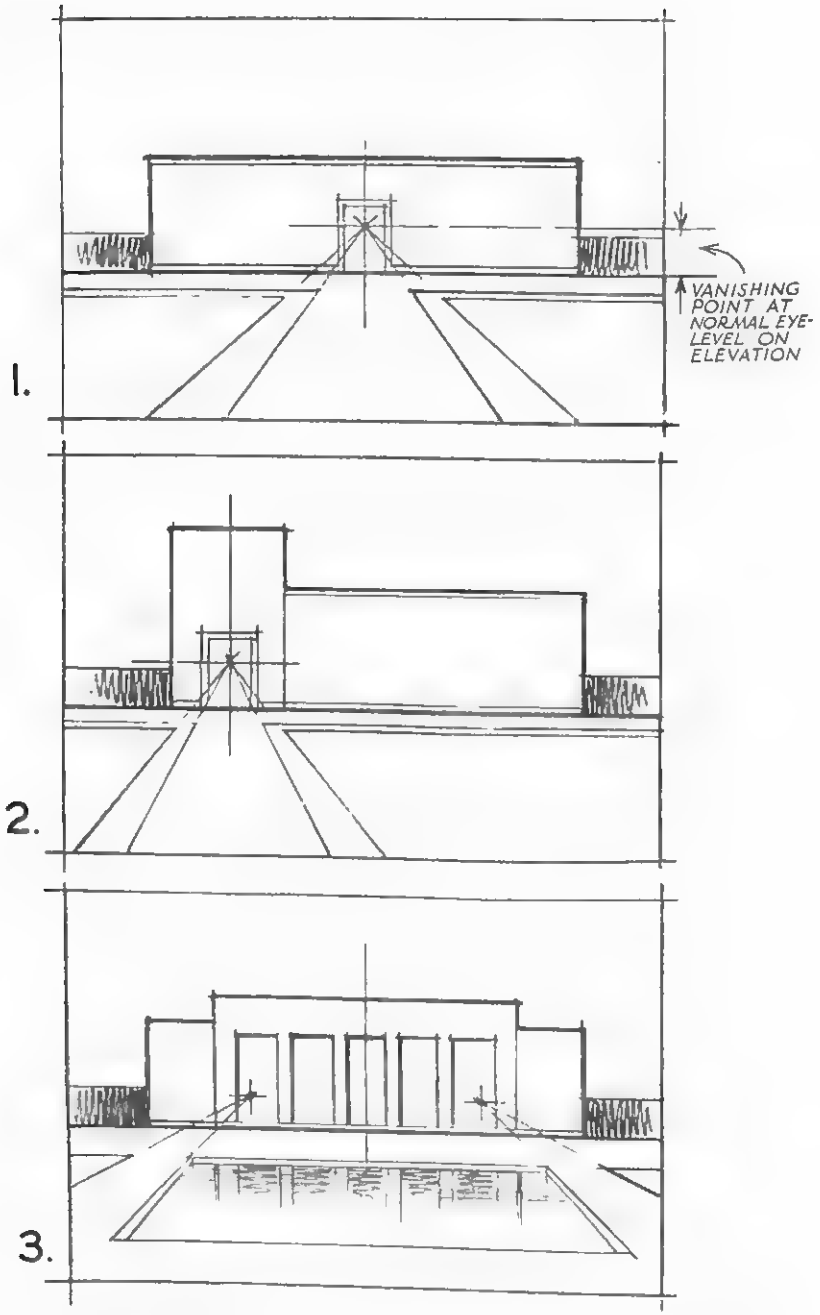
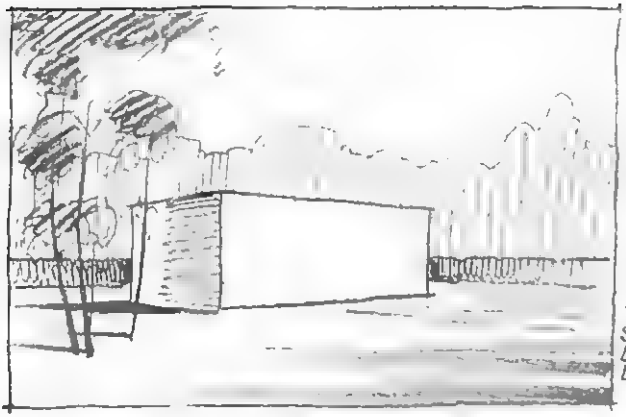
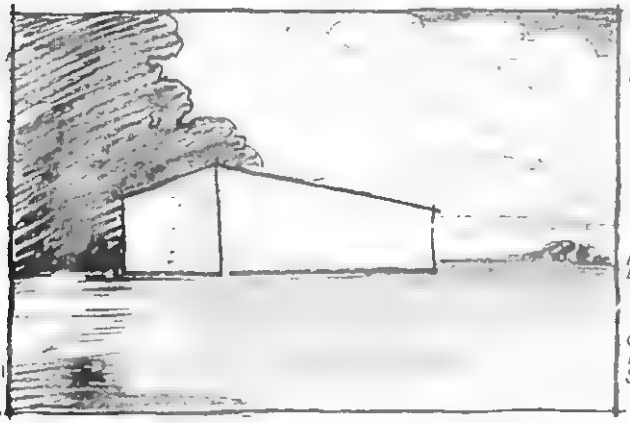
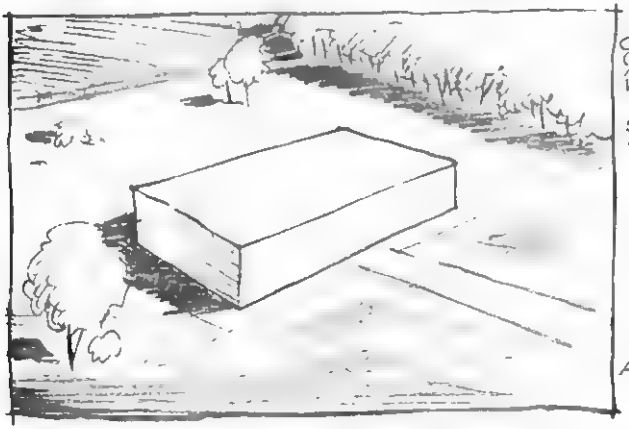

VANISHING POINT AT NORMAL EYE-LEVEL ON ELEVATION
1.
2.
3.
FOREGROUND

Fig. 134







SURROUNDINGS *PERSPECTIVES* Fig. 135

Fig. 136 illustrates some common types. After getting a grasp of these it is a matter of individual observation and experiment. A small pocket sketch-book is useful for noting down interesting skies from nature.

Sketch (1) shows the formal treatment usual with wash drawings. The sky is cloudless and graded from relatively dark at the top to light at the horizon. Although there are many different cloud effects in natural skies most "architectural" skies can be dealt with either by the introduction of bunched cumulus clouds or of layers of stratus clouds. Sketch (2) shows the former; sketch (3) the latter, and illustrate the general effect of each. Sketch (4) shows a perspective with clouds similar to (2), and sketch (5) a perspective with "cirrus" clouds of a like character to (3), but having a more lively effect. Note how the clouds follow the lines of perspective.

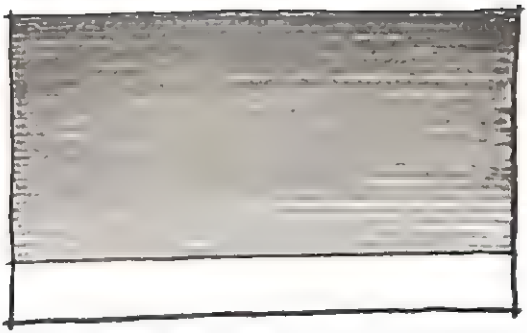
By whatever technique the clouds are represented there are two important points to be borne in mind: (1) the edges of clouds are invariably soft, and (2) clouds are just as much elements in the general composition as anything else—the sky must not be such a *tour de force* as to overpower the building.

Trees

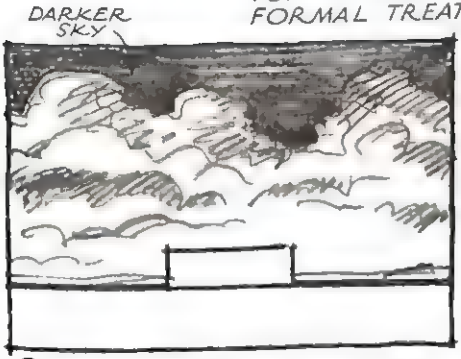
Most architectural renderings include trees of one kind or another. As with clouds, there are many different types and many ways of drawing them, both conventional and naturalistic. Again, too, it is largely a matter of observation and experiment on the part of each individual.

Fig. 137 shows the drawing of various types of trees. These have been drawn in soft pencil and the drawing would be modified for other media. In the top left-hand corner is the tree which often occurs on the beginner's early drawings, but fortunately nowhere else. Two conventional types of trees are shown next in elevation and plan based on circles and squares; their use is restricted to formal renderings where it is desirable not to disturb the strictly architectural lines of the drawing. In the right-hand top corner is a more natural representation which might be described as a "general purpose" tree.

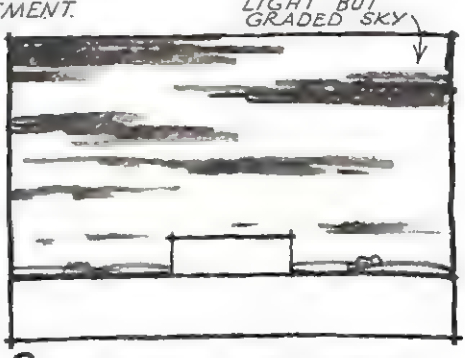
As one of the reasons for putting trees on drawings is to help express the actual size of the building, the trees themselves must be to scale. When the representation is obviously that of a full-grown oak somewhere near to the building, for example, it is absurd to find it scaling 10 or 15 feet in height. The sketches on the second row of the Figure shows sizes of certain types of trees compared to that of a man.



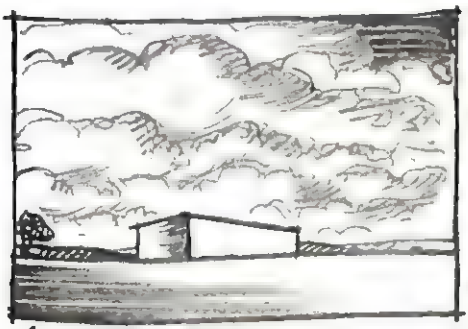
1. NORMAL CLOUDLESS SKY USUALLY EVENLY GRADED FROM DARK AT TOP TO LIGHT HORIZON - FORMAL TREATMENT.



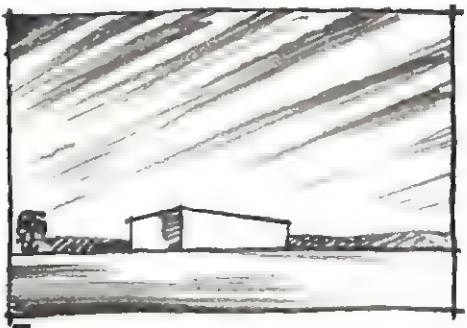
2. ELEVATION WITH BUNCHED MASSES OF CUMULUS CLOUDS 'LIVELY' EFFECT.



3. ELEVATION WITH LAYERS OF STRATUS CLOUDS. 'REPOSEFUL' EFFECT.

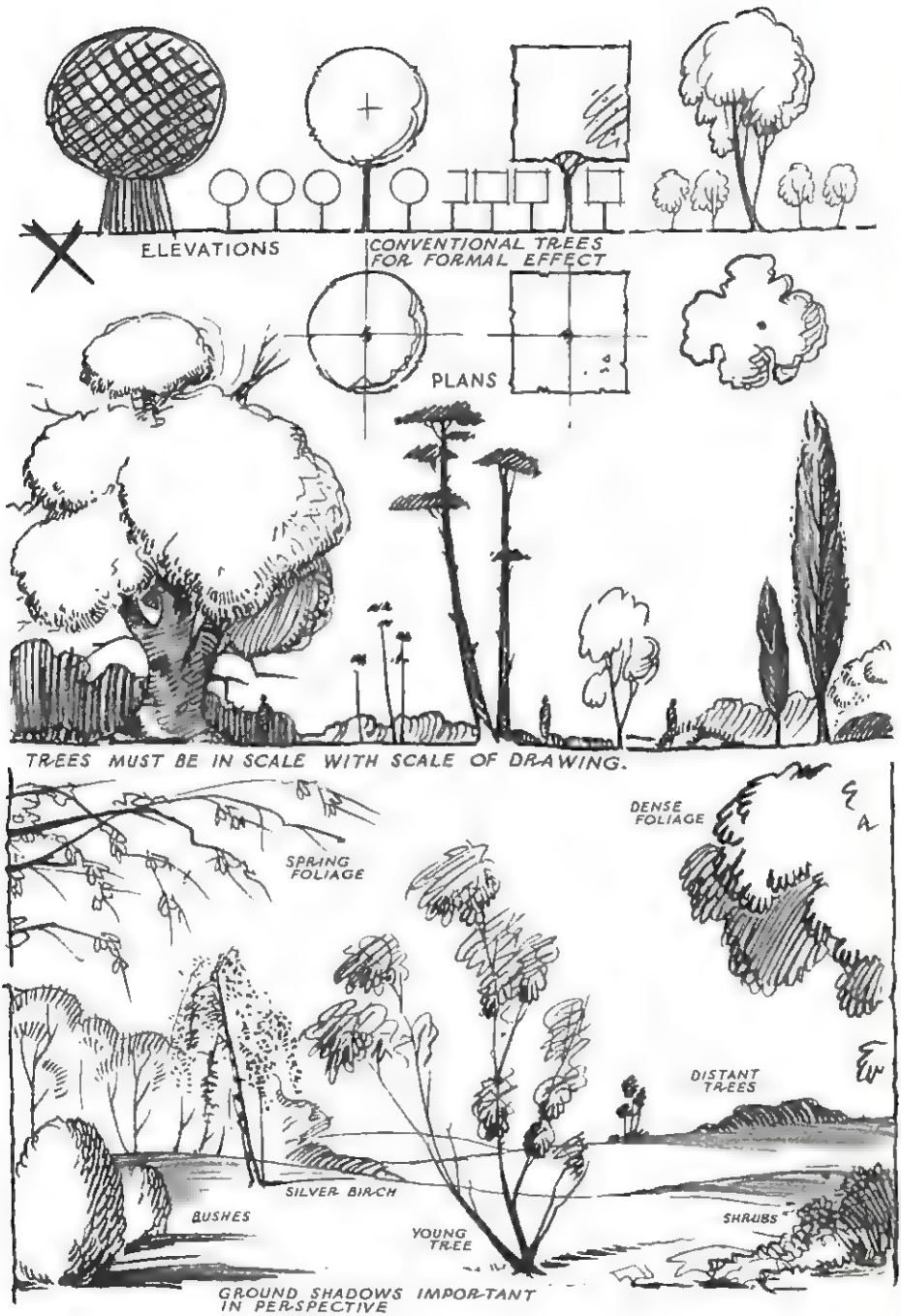


4. PERSPECTIVE WITH CLOUDS AS IN 2.



5. PERSPECTIVE WITH CIRRUS-TYPE CLOUDS.

SURROUNDINGS *SKY & CLOUDS* Fig. 136



SURROUNDINGS *TREES*

Fig. 137

Points to be borne in mind in drawing trees are:

(1) Trees must look as if they are growing out of the ground, not "floating" in the air. An indication of the swelling towards the roots, and shadows, are helpful in this respect.
(2) If a tree is meant to represent a particular species, it must look something like that species.
(3) Trees should never appear to be growing out of roofs. Isolated trees behind a building are best omitted, unless they can be related to similar trees, the whole of which can be seen at the sides of the building.
(4) The trunk and branches must seem able to support the foliage.
(5) The foliage must appear to be rounded, not as if cut out of cardboard.
(6) Trees should not be overdrawn and laboured, especially if they are to be coloured. A suggestion of the main lines is sufficient.
(7) Near trees in perspective are seen in more detail than distant ones, which can be resolved into mass only.

Stretching Paper

Before going on to describe rendering in wash and other techniques the method of stretching paper must be dealt with. Drawings which are made in line only or which are rendered in one of the "dry" media—pastel, crayon, etc.—can be made on paper which is pinned to the drawing board, but if washes of Chinese ink or water-colour are to be used, or if the drawing is to be sprayed, then it is necessary to use stretched or mounted paper which will not cockle when wet. Mounted papers of good quality are expensive and have certain disadvantages. For "wet" drawings, therefore, the paper, which must be hand-made, like Whatman's, and the thicker the better, is usually stretched in the following manner, as illustrated in Fig. 138:

(1) The right side of the paper is found by holding it up to the light so that the watermark can be read.
(2) The paper is laid on the board with the right side uppermost and the edges are turned up about $\frac{1}{2}$" to $\frac{3}{4}$" to form a shallow tray.
(3) The paper is then turned over and with a sponge water is applied around the edges up to the folding mark—the $\frac{1}{2}$" to $\frac{3}{4}$" strip not being wetted as this is later to be pasted. The sponge is next applied diagonally and to the main axes, "union jack" fashion, and these bands are thoroughly wetted. The whole sheet, except the pasting strip, is then wetted and allowed two or three minutes for the water to soak in. Any standing water is removed at the end of that time.
(4) The paper is turned back right side uppermost, the edges are made square with the board, and water is liberally applied to the upper surface particularly around the edges which were not wetted on the underside. After this operation the paper should be covered with buckles and pools of water.
(5) Paste is now quickly applied to the outside dry edges of the underside, starting with one of the short sides. When all the edges are pasted, some of the standing water can be removed but a pool must be left in the middle. The edges of the paper are again adjusted square with the board. The middle of the short side first pasted is then taken, pressed firmly down and with thumb and fingers pulling and pressing the edge is stuck to the board along to the corners.

The opposite edge of the paper is then lifted carefully and slightly by the corners and pulled gently so as to free the underside of the paper from moisture-adhesion to the board. It is then stuck down as before, pulled strongly by the fingers first at the middle and then outwards to the corners. The two short edges now being held, the long edges are stuck down in the same way, starting at the middle and working to the corners, pulling and pressing until the whole sheet is flat and firmly stuck down all round.

An extra pressing can be given to the stuck edges by means of a hard but smooth object such as the handle of a knife or a coin edge, etc. If the paste is satisfactory nothing more is necessary in this respect, but if any doubt is felt, drawings pin can be put in at weak points or at intervals around the sheet after the edge has been dried off a little with a clean cloth. Or, alternatively, strips of adhesive paper can be stuck around the sheet, half on the paper and half on the board.

When the sheet is satisfactorily stuck down, all standing water on the surface is removed with the sponge, and the paper is mopped off gently without scrubbing from the edges inwards so that the part to dry last is the middle.

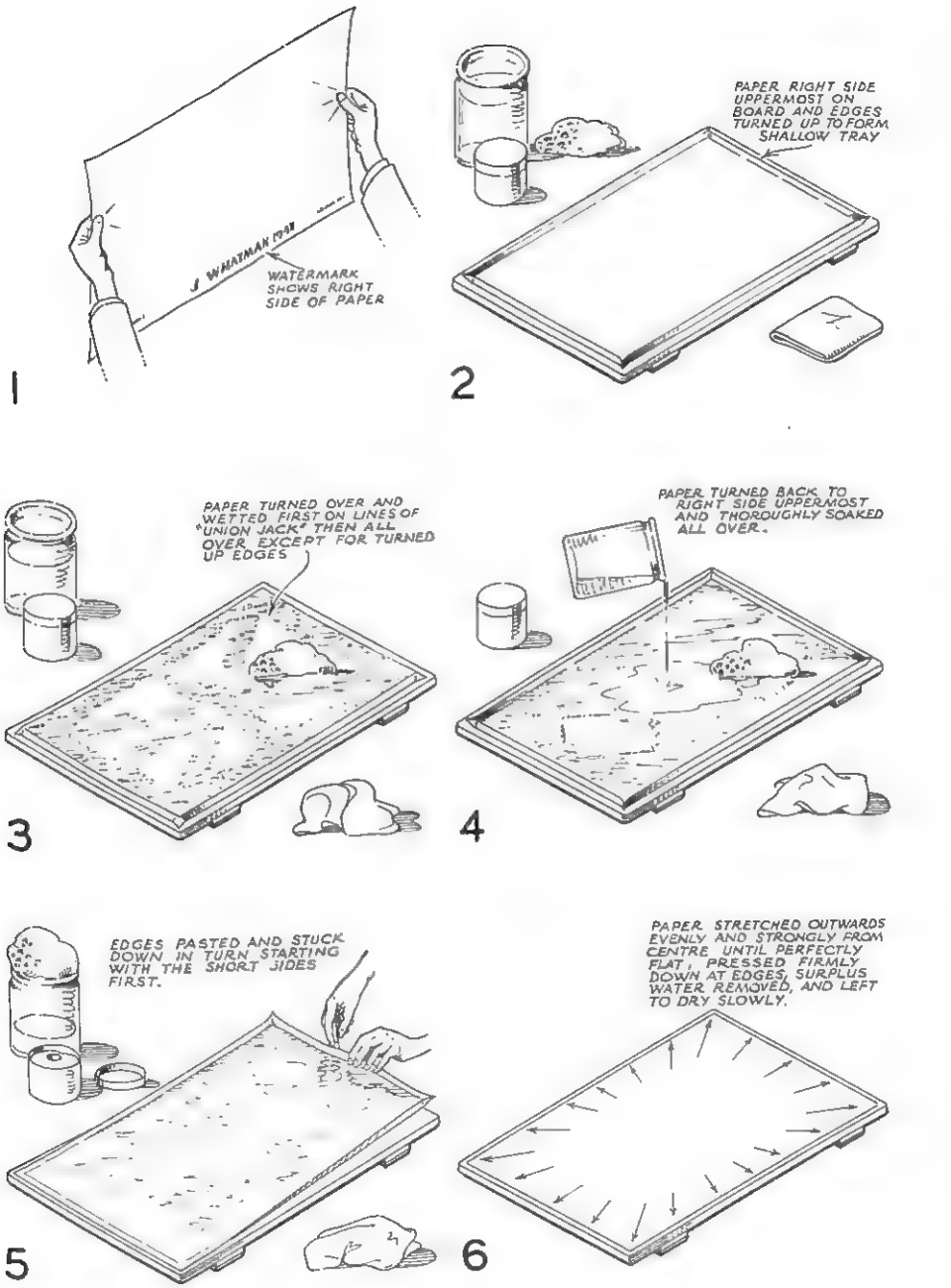
The process of drying cannot be hastened without risk, and until all signs of dampness have disappeared the board must be kept horizontal. Time for drying will depend upon a number of factors. It can be lessened by placing the board in a draught, either near an open window but away from direct sunlight and soot specks or from an electric fan. If the drying is done too quickly the paper may split or come off.

If, for any reason, the edges of the paper or the tape have to be turned down over the edges of the board, they must be trimmed off afterwards with a sharp knife or razor blade to allow the T-square to run smoothly.

Sometimes, even with every care, the sheet comes off altogether or in part while drying, or fails to dry out properly, leaving ridges and buckles. If the drawing is to be an important one, the only thing to do in such cases is to start afresh with a new sheet of paper, although if the first sheet is not damaged it can be used again for another drawing.

If it is a case of slight ridging—usually in the corners—and a large number of big washes are not required, then by thoroughly wetting the surface of the paper and allowing it to dry out again very likely the ridges will disappear. The paper will at best, however, be only lightly stretched and the running of washes will cause it to buckle temporarily and may prove a nuisance.

If the sheet comes off along one or two sides only, and is otherwise firmly held, the stretching can often be made good. The underside should first be wetted as far as possible with the exception of the pasting strip; then the top surface is thoroughly wetted and the water allowed to soak in; new paste is applied and the sheet firmly stretched and stuck down once more and allowed to dry out slowly.



STRETCHING PAPER

Fig. 138

Rendering in Wash

As an introduction to all kinds of rendering, that using washes is of the greatest value. While its practice is less extensive than at one time it is still the most suitable for formal drawings of a dignified character. Exercises in wash rendering are the surest guide to all the basic principles, and provide excellent discipline for the hand and eye.

The first step after the completed line drawing in pencil has been carefully checked, is to clean it up if necessary, and then to give it a wash of water over the whole sheet. The purpose of this is not, as is sometimes thought, to remove the ingrained dirt from the paper, but to remove any loose pencil dust, grease from the hands, etc., and, most of all, to overcome dryness in the paper, especially if it has been exposed on the board for a long time. This water wash also has the effect of "fixing" the pencil lines to some extent, making them more difficult to rub out, which is why the checking must be done before.

Next, the shades and shadows, see p. 152, are worked out on tracing paper and transferred to the drawing. A further water wash may then be given, but is optional. Some draughtsmen mix a very little alum with the water washes (one tablespoonful to a quart of water) as this is supposed to help remove grease and make the later washes run better.

Water washes are put on like any other wash, and the procedure is illustrated in Fig. 139. The board should be tilted slightly, not more than about 1 in 10 or about 5 degrees. The upper end is best supported on a suitable block of wood rather than on unsteady books, etc. The way up of the board depends on the area to be dealt with; generally, it is easier to work with the lesser dimension running horizontally, e.g. in the case of an over-all wash, the board would be as shown in Fig. 139.

Elementary Laying of Washes

Washes must always be run from the highest part to the lowest. The procedure is to fill the brush—wash brush, p. 17, for large areas—and start along the upper edge of the area, putting on a good deal of the liquid, working it carefully to the top line.[1] Then by means of long regular horizontal brush strokes with short vertical ones at the sides, bring the wash down the sheet or area, keeping it evenly wet all the time. The brush should not "paint" the paper but merely touch the raised edge of the wash and guide it along.

It is particularly important with washes of heavy water-colour

[1] It is, of course, unnecessary to work to border lines if the sheet is to be cut off along them afterwards.

LAYING A WASH

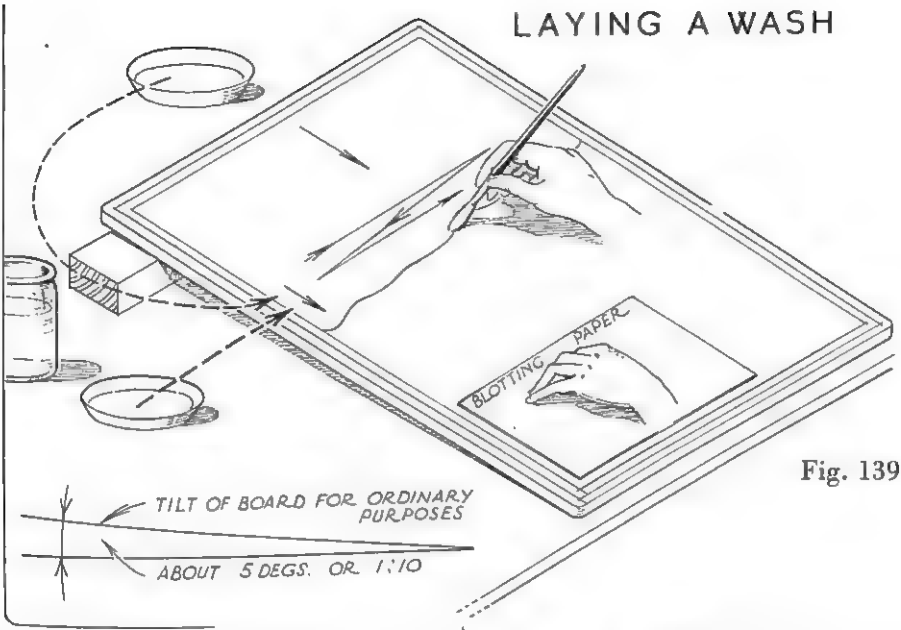


Fig. 139

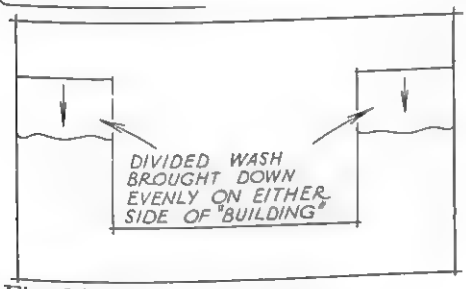


Fig. 140

Fig. 141

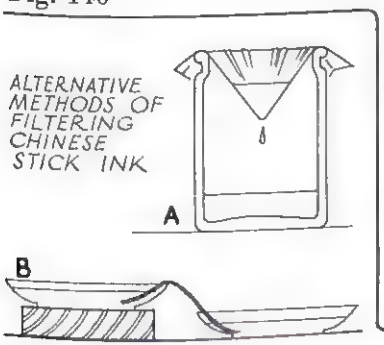


Fig. 142

CHINESE STICK INK

to work slowly and smoothly or the deposit of the colour will be irregular and unpleasant.

When the wash has been brought to the bottom of the area it must be finished off carefully along the line, and this is sometimes more easily effected with a smaller size of brush, say No. 6. The wash will tend to collect at the bottom, and the surplus must be gently removed by holding a squeezed-out brush just touching it so that the liquid is drawn up into the hairs. This operation is repeated as many times as necessary to ensure that the wash dries evenly from the top downwards.

If properly put on a wash should show a perfectly regular tone, colour or mottle over the whole area.

If the wash is in two parts for a distance, e.g. passing on either side of an elevation, as in Fig. 140, the two parts must be kept moving equally and evenly. It is easier in such cases to start with the divided parts, doing a bit to each in turn.

Brushes loaded with water or wash should not be carried over the drawing any more than necessary because of possible drops. Fig. 139.

Above all, washes must be run "wet". There must be enough wash mixed up at the beginning to cover the whole area; it is fatal to success to have to stop in the middle of putting on a wash to mix up some more.

Defects in Wash Rendering

The following are the defects most likely to occur in wash rendering. They should be guarded against so far as possible, but can sometimes be remedied as described.

(1) *Untidy Edges.*—Caused when the wash overruns or falls short of the enclosing lines. To remedy, when the wash is dry, take a small brush, dip it in clean water and dampen the edges affected and blot them off with clean blotting paper several times until all traces of the over-run or the sharp edges of the short wash are removed. This matter should be attended to after every wash and the defects not allowed to accumulate. Stubborn over-runs can be quickly cleaned off by holding a piece of thin card (post-card) along the true edge of the wash and taking a small piece of sponge dipped in clean water, wiping away gently the over-run.

(2) *Blots.*—Caused by drops of colour falling on the rendered parts of the drawing. If blotted up immediately—a piece of clean blotting paper should always be handy, but sacrifice a handkerchief if necessary—nothing may show. If the marks have been overlooked and have dried, take a bluntish brush and clean water and gently wash over the spots repeatedly with alternate blottings until they are light enough to be blended in as described later.

(3) *Run-backs.*—Result from a collection of wash at the bottom of an area seeping back up the partially dried upper part or, sometimes, from the addition of a quantity of wash to an area which has been run rather on the dry side. If serious nothing much can be done to

remedy this defect and the whole area may have to be sponged out with clean water when quite dry. In less serious cases, the specks of pigment which float back can be picked out carefully with the point of a brush and the worst effects are somewhat mitigated. In free water-colour renderings, run-backs are sometimes deliberately sought to build up a striking effect, but this is no trick for beginners.

(4) *Streaks.*—Horizontal lines of darker colour are usually caused by running the wash too slowly or unevenly, or by a defect in the paper —spoiled surface due to previous rubbing out— or impurities in the wash. If serious, lift the board and with sponge and clean water gently sponge over the area trying to remove the streaks. Do not start sponging until the area is dry all over. Avoid scrubbing the surface or it will be ruined. Streaks are less likely to occur with light washes, and for formal drawings, tones should be built up by a succession of washes. Sometimes, the streaks can be turned to account if occurring in the "sky" by being made into clouds.

(5) *Grease Spots.*—Small spots which refuse to take colour are due to some sort of grease or water-repellent having affected the fibres of the paper. If not too large, these can be patched up to match the rest of the wash by stippling on colour with the point of a small brush or by cross hatching also with the point of a small brush much in the manner of "darning". With patience and a steady hand almost "invisible repairs" can be made. The air-brush, p. 191, can also be used for this work.

Sponging Off

Reference has been made to the sponging off of defective washes; it is also a useful procedure to soften the tones of a rendering in Chinese ink or water-colour and to remove any hard edges. The sponging should always be done when the drawing is evenly dry all over, with a maximum of clean water and the minimum of scrubbing.

General Procedure with Wash Drawing

Rendering should follow an orderly sequence and should proceed evenly over the whole sheet. It is bad practice to render up one portion of a drawing completely before the rest, the result is bound to be patchy.

A scheme of tones should be determined at the beginning. This can be worked out by means of thumb-nail sketches in soft pencil. The big washes should be put on first, starting with the general tones, then the lesser ones gradually working down to the final accents. A light even tone to establish shade and shadow areas can be applied at an early stage with advantage; later the tones can be strengthened and graded as necessary.

Generally, unless the area is very small, it is better to build up tone value by a series of washes rather than to try and do it in one wash. By building up gradually the correct tonal relationships between the various parts can be maintained more closely and the desired balance systematically achieved, whereas

to get correct final tones by single washes, although possible and quicker, requires considerable experience.

Tones should be carefully related in strength to create the illusion of perspective in an elevational drawing, to get the effect of light and shade on the building, and to emphasise the composition of the picture. There should be a scheme of tones whereby distant planes appear to recede in a logical sequence. Usually the foremost façade of the building is the lightest tone, the vertical planes behind it getting darker the further away they are, Fig. 143 (3), but the flanking parts of an elevation may be kept dark to avoid taking the interest away from the centre, e.g. if the building is U-shaped with projecting wings the order of the tones might be reversed.

The strengths of shades and shadows and accents generally should be most intense on the lightest plane, concentrating in effort at the visual centre of interest, and getting relatively weaker on successive darker planes.

If the foreground is a more or less horizontal plane it should be graded from dark at the bottom of the picture to light near the principal face of the building. It should also be somewhat darker at the sides. The building will appear to "float" if the foreground is too dark, Fig. 143.

The sky should be graded, even if later broken up by clouds, from relatively dark at the top to light at the horizon, Fig. 143 (1) except in the case of very tall buildings, when a better effect is sometimes obtained by grading in the reverse way, Fig. 143 (2).

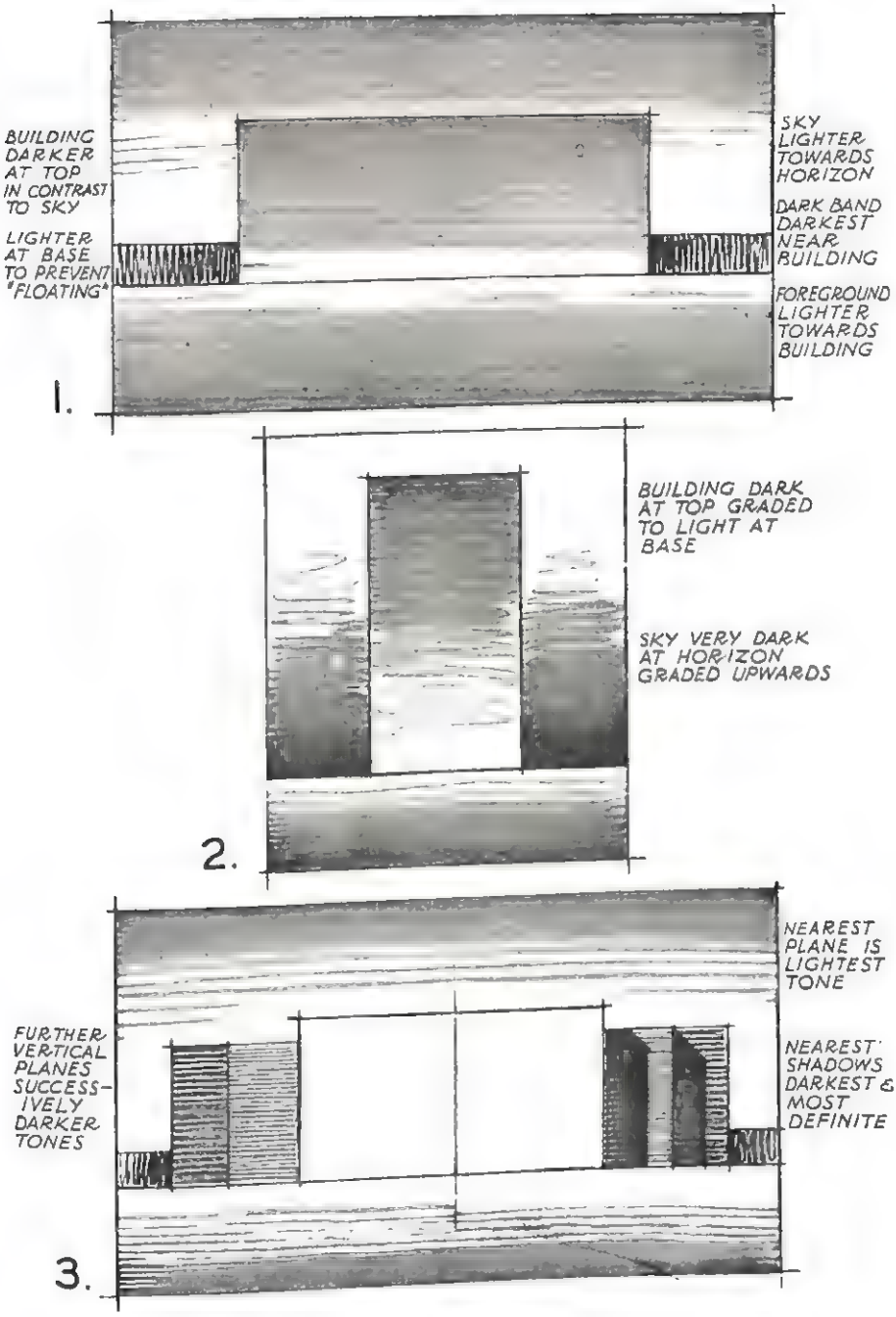
Graded washes should be applied to inclined planes, e.g. roofs, to give contrast with adjoining areas. Usually, steep pitched roofs should be darker towards the top; flat pitched roofs darker towards the eaves.

It is advisable to grade all principal washes. The picture is thereby greatly enlivened and corresponds more closely to reality. The building should be graded to heighten the contrast with its surroundings and to acknowledge the effects of reflected light, i.e. lighter towards the bottom if paving or light ground, darker towards the bottom if dark grass, etc. The grading should be gentle. Shades and shadows should also be graded.

Media

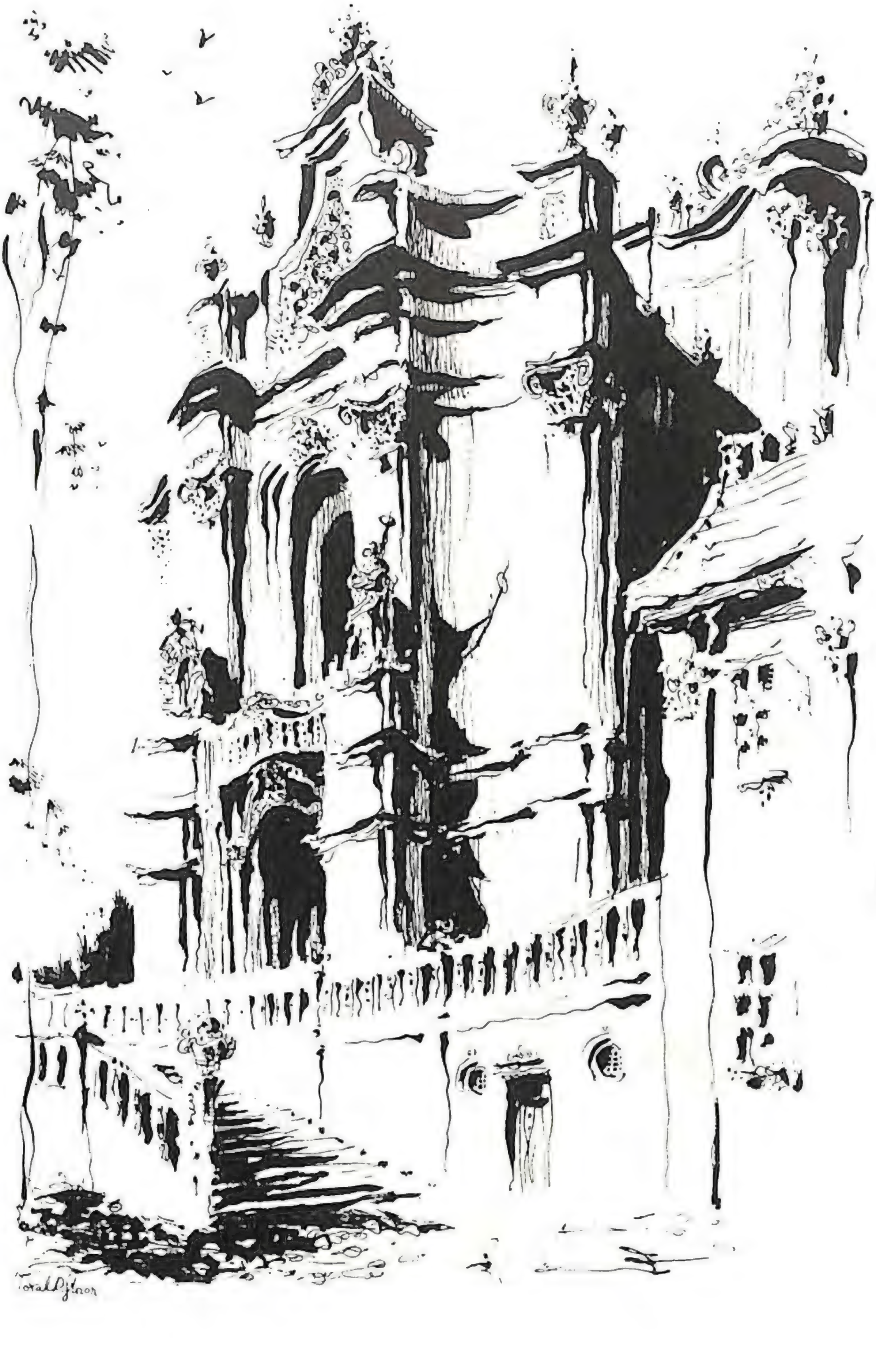
The principal media used for rendering drawings are:

(1) Chinese ink washes.
(2) Water-colours.
(3) Poster colour.
(4) Pastel.
(5) Coloured pencils.
(6) Pencil only or black ink only.



TONE VALUE

Fig. 143



All of these can be used by themselves or in combination with one or more of the others. It must be emphasised again that it is by personal handling of these materials and the study of actual drawings that the full possibilities of each will be realised. It is not attempted here to do more than give a few suggestions and hints.

Chinese Ink

Chinese ink is obtained in sticks usually marked with Chinese characters. There are various sizes, but quite a small one will last some considerable time. The quality also varies; the cheaper being rather harsh and cold in tint, the more expensive is warmer and is always to be preferred. The particular value of the ink is its transparency, which gives to a formal wash drawing a finish difficult to obtain by other means. It is especially useful for early exercises in wash rendering and for neutral washes on any kind of drawing.

The ink is prepared for use by being rubbed down with a little water on a slate slab or in a saucer, Fig. 141. If a quantity of wash is required it is advisable to rub down a strong mixture —almost black in intensity when tried out on a piece of paper— which can be subsequently diluted as needed. The liquid must be filtered after being rubbed down, by being passed through fine muslin or coarse filter paper until all specks are removed. An alternative filtering process is to soak a small piece of string in water and by putting one end in a saucer at a lower level and the other end in a saucer of the ink at a higher to allow it to pass through by capillary attraction which filters it at the same time, Fig. 142.

The filtering process is of the greatest importance and must be carefully carried out. The filtered ink can be stored in a clean bottle with a clean stopper or covered over with damp blotting paper for several days.

After use the stick should be wiped dry or it will crack and become useless.

The ink should be used in light washes, dark tones being gradually built up, the general procedure being as described for wash rendering. The ink dries much lighter than it appears when wet. Water-colours, such as Cobalt Blue, Viridian, Burnt Sienna, Raw Sienna and Carmine, can be added in small quantities to tint the ink if desired.

Water-Colours

Some reference has already been made to water-colours, p. 15. For formal rendering in wash it is usual to work with mixtures of Burnt Sienna and French Ultramarine, or Raw Sienna and

Ivory Black, or Cobalt Blue and Light Red. These mixtures should be definitely inclined in hue towards one or other of the constituents. In all cases, the colours are deposited as the wash is run, forming what is termed a "mottle", and it is by the speed and manipulation of the brush that the most interesting effects are obtained. Knowledge of this can only come by experiment. It is essential, of course, that the wash is put on evenly and kept very wet. And, as the pigments tend to be deposited in the jar or dish, the wash must be stirred up every time a brushful is taken. As with Chinese ink, if a good quantity of colour is required, it is better to mix the whole lot at the beginning rather than have the difficult task of mixing new washes to match the original at various times.

It is not possible to discuss free water-colour rendering in detail. Water-colour is perhaps the most flexible media of all, and can be used with success for every type of drawing. Experiments should be made at first with a few colours, and then new ones can be added to the palette and others discarded according to individual preference. A wide range is seldom necessary; many successful water-colourists manage with about half a dozen only.

A few hints are: Avoid Prussian blue and Van Dyke brown which stain the fibres of the paper and cannot be sponged out if anything goes wrong. Never mix ultramarine and vermillion; a chemical reaction produces a black sediment. Always put the colours on wet, except for an occasional dry brush stroke for foreground treatment or other special effect. Try to let the colours do the work; avoid "painting" them on thickly and muddily, let the white of the paper show here and there for high-lights and sparkle. Vivid colours should be reserved for accents and spots of interest; large patches of them are garish. Cobalt is the best blue for skies. Burnt Sienna with a little ultramarine is better for brickwork than any red. Raw Sienna is a useful colour for light tones on stonework, etc.

Poster Colours

The colours, see p. 15, are the equivalent of water-colours mixed with Chinese white. They dry with a flat matt surface of even tone if properly applied, and because of this are often used to represent buildings of simple form and sharp outlines, and particularly for interior design drawings. It is essentially a medium for strong if not bold effects.

Poster colour can be used in combination with water-colour or with pastel, e.g. a building largely coloured in poster colour with a water-colour or pastel sky. The colour must not be too wet when applied to the paper or it will not dry evenly. A second

coat must be applied fairly dry or excess water will be absorbed by the first, which will mix with the second or be pulled off by the brush. For large areas of thick colour which are to be gone over owing to alterations, it is safer to remove the first coat with a knife or with a wet brush and blotting paper. If the colour is applied too thickly it may flake off when dry. Small but regular areas of colour can be outlined with the ruling pen and filled in with the brush before the lines are dry. Brick courses can also be ruled in to small scales. Poster colour or Chinese white can be superimposed over Indian ink, but Indian ink cannot be superimposed on either of the former. Fine detail can often be effectively added to poster colour by drawing on it with a sharp HB pencil, the line appearing with unusual brilliancy. Although poster colour covers up original pencil lines, this should not be made an excuse for careless draughtsmanship.

If Designers' Colours are used, the following are useful colours which will meet most requirements: Black, White, Indigo, Lemon Yellow, Red Ochre, Raw Sienna, Vandyke Brown, Ceranium Red.

Pastel

Pastel is used in architectural rendering for applying soft, graded tones and colours to the comparatively larger areas of the drawing.

The method in general, see Fig. 144, is to scrape off with a penknife or to crush a small quantity of pastel on to a sheet of cartridge paper, known as the rubbing sheet, until a very fine powder is obtained, and then to pick it up with a piece of cotton-wool and apply it to the drawing by firm even rubbing, the parts of the drawing not to be pastelled being masked by thin card or stiff paper.

Only the best pastels of finest grain should be used. There are many different colours and tones, so many that it is best to start with a representative selection and add and discard as suggested for water-colours. Strong, vivid colours are little used; useful ones are: Raw Sienna, Autumn Brown, Green Grey, Indian Red, Prussian Green, White and Black. The colours can be blended together on the rubbing sheet.

The medium lends itself well to sky effects, a wide range of soft tones being easily obtained. "Breaks" can be made in the clouds by removing some of the pastel with a plastic rubber. The main tones on buildings can also be applied lightly with grading, and a suggestion of foreground can be given by rubbing off a little pastel downwards from the ground line of the elevation.

Pastel by itself is seldom sufficient and the accents of the rendering can be given by touches of poster colour, e.g. ruled window-bars, etc., flowers, trees, figures, etc.

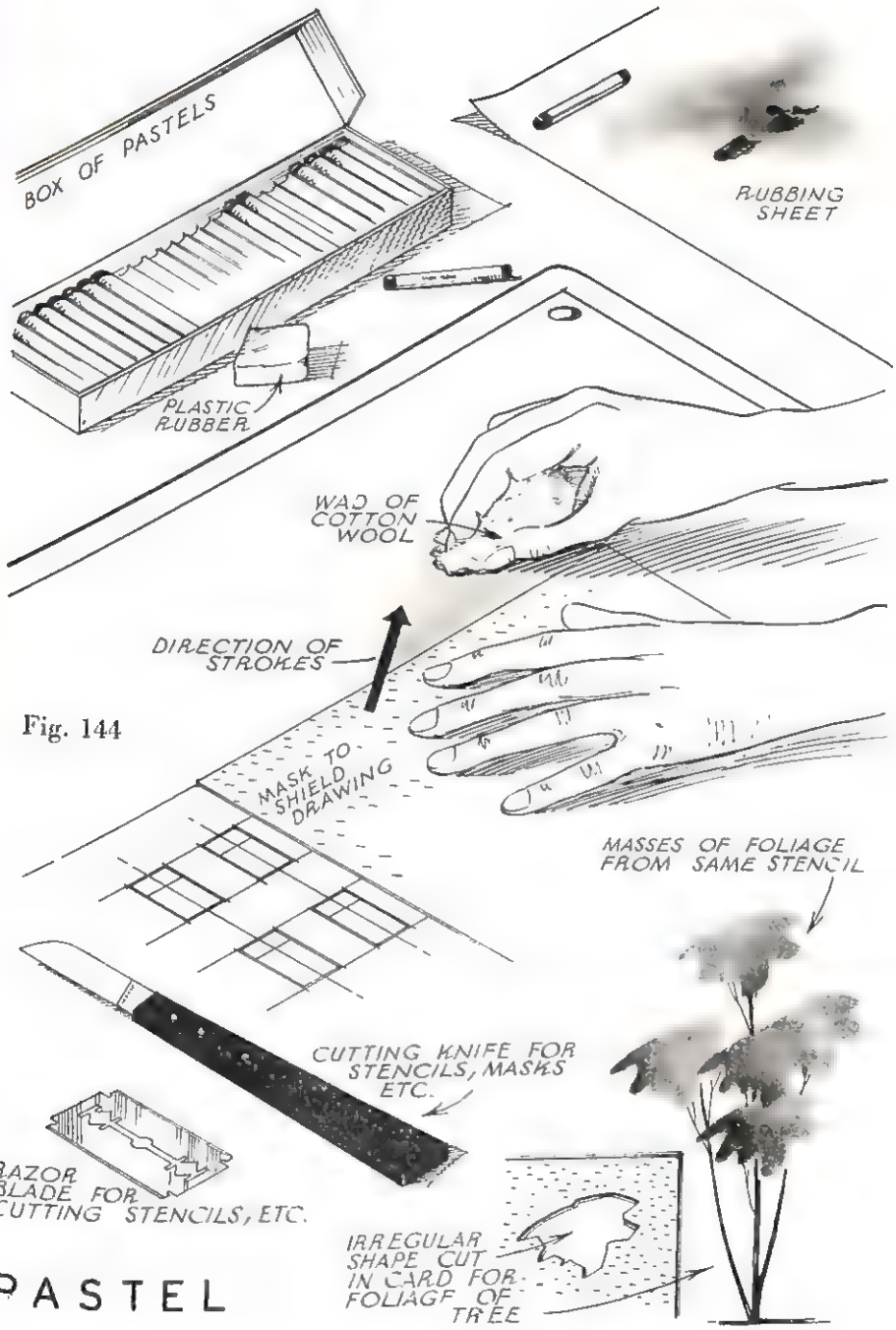


Fig. 144

Fig. 145

Trees can, however, be pastelled by cutting an irregular shape in a thin card and by rubbing through this to build up a mass of foliage, as shown in Fig. 145, the trunk and branches of the tree being added by thin brush strokes of dry poster colour dragged upwards from the ground.

The chief disadvantage of pastel is the amount of dust which gets on to hands, clothes and sometimes, the wrong parts of the drawing.

Coloured Pencils, etc.

The use of coloured pencils is restricted in the main to good-sized drawings to a fairly large scale, although in combination with ordinary pencil or Indian ink detail can be satisfactorily tackled. The advantage of using coloured pencils lies in the ease and speed of the medium and the wide range of tone values according to pressure. The technique can vary from free coloured sketching to quite formal renderings wherein regular, even tones are obtained by carefully ruled close parallel lines. The applying of colour and tone by indiscrimate scribbling must be avoided.

Crayons and chalks can be similarly employed. For rapid, broad effects the best medium is charcoal. The sticks should be held almost parallel to the paper in use and not like a pencil. Tones can be obtained by smudging with the fingers.

Drawings in charcoal, crayon, or any powdery medium need to be protected on completion by being sprayed with a fixing liquid.

Pencil

Pencil renderings in general consist of the addition of shadows and surroundings in line. Shadows, for example, often being indicated by close parallel lines, either horizontal or vertical, according to the area concerned. Gradations of tone can be obtained by varying the pressure on the pencil and sometimes by cross-hatching. A little smudging by the finger, however, can be done to add indefinite tones for clouds, foliage, etc.

Lines in Indian ink to the silhouette of the building or for accents and points of emphasis can be used on otherwise pencil drawings.

Pen and Ink

Formal drawings completed wholly in pen and ink are very infrequent, the technique being more often used for freehand sketches on the lines described in Chapter IX.

Small-scale elevations, however, can be effectively shown in

ink with blacked-in openings and the addition of very simple surroundings in line.

Perspectives also must be fairly small to be successfully executed in ink. Large drawings in the medium, unless the brush supplements the pen, tend to look laboured and restless. The mapping pen, incidentally, generally gives too fine a line for any but the smallest drawings.

As variations of tone cannot be obtained directly with ink, greater use has to be made of different thickness of line, cross-hatching, dots, dashes and areas of solid black, and the possibilities of these should be thoroughly studied.

Sepia ink is a possible alternative to Indian ink, and wash—sepia or ivory black water-colour—combined with ink drawing opens up wider fields of expression.

Spatter, Spray, and Air-Brush Techniques

Water-colour and Chinese ink, instead of being washed on with a brush, can be applied to drawings in the form of minute particles by the following methods:

Spatter

For small areas, especially shadows on $\frac{1}{8}''$ and $\frac{1}{16}''$ scale elevations, colour can be spattered on using a tooth-brush or similar stiff brush and a piece of fine wire mesh, as shown in Fig. 146. The ink—Indian ink is commonly used for shadows—or poster colour is mixed in a dish and picked up by the brush, which is then rubbed backwards and forwards over the mesh, held horizontally a short distance away from the paper. The brush must not be too wet or splashes will mar the fine texture which can otherwise be obtained. It is comparatively easy to grade evenly quite small areas by this method. Great care must be taken to mask all parts of the drawing not to be spattered, even those some distance away from the operation. The usual practice is to fit pieces of stiff paper carefully to the outlines concerned and to hold the edges flat with coins or similar small heavy articles. The slightest separation of the surfaces of the drawing and the mask will allow the spatter to find its way in and spoil the sharpness of the edge to which it should be confined.

Spray

For large areas, particularly skies, water-colour can be sprayed on using a metal spray of the type sold for spraying fixing liquid on to charcoal drawings and costing only a few pence, as illustrated in Fig. 147, or an atomiser such as a throat spray. The particles of colour are much larger by this method; this may be an advantage for bold drawings.

It is again necessary to cover the parts of the drawing not to be sprayed, but as it is better to stand the board vertically, a mask or template is cut out of thick tracing paper or detail paper and held in position by ordinary pins about an inch apart close to the edge. The pins must be carefully placed so that the prick marks, which should be very slight, do not show afterwards. For small areas, which cannot be easily masked in this way, a coating of rubber cement diluted with benzine can be painted on and later removed quite cleanly.

The spray should be blown horizontally to the drawing from two or three feet away at least, so that any large, heavy drops fall clear of the drawing and only the finer particles impinge on the surface.

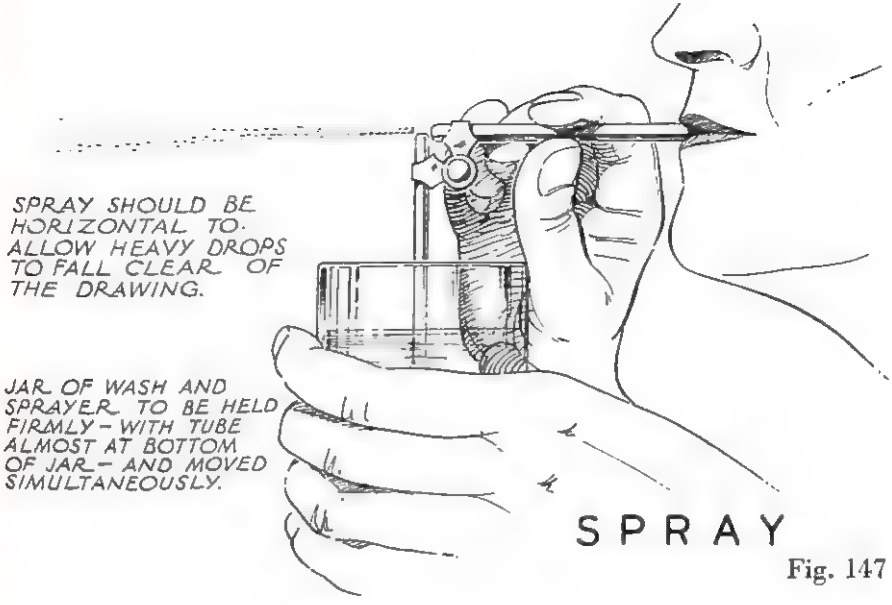
The spray should be kept steady in force and should be moved about to prevent any one part of the surface becoming too wet and causing the particles to run together. The process should not be rushed, but the mask must not be allowed to cockle or shrink. If the spray does, however, fall outside its intended limits, it can usually be washed off afterwards with a brush and clean water. It is said that a little alcohol added to the liquid gives a finer spray and quickens the drying.

The strength of the spray is difficult to judge until the mask is removed, but a corner can always be turned down at intervals and affords some guide.

Any colour can, of course, be sprayed on. By spraying with alternate constituent colours a brighter combination on the paper can be obtained than by mixing them together first in the wash. Settlement of the pigments in the wash must not take place or the colour of the spray will vary.

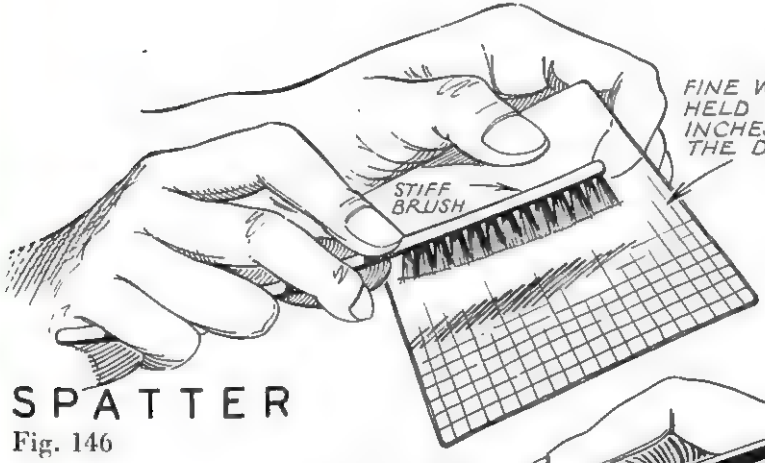
Air Brush

For large and small areas and for fine and regular sprays there is nothing to surpass the air-brush, which is operated by compressed air, see Fig. 148, although the expense is probably only justified when a considerable number of drawings are being dealt with continually. The compressed air is supplied from a cylinder charged by means of a foot-pump or electric compressor, through a rubber hose to the "brush", which has a receptacle for ink, colour, etc., and a control button for varying the spray. With a little practice interesting and beautiful renderings can be carried out. The main danger to guard against is the somewhat "artificial" air which the mechanical perfection of the spray tends to give. Masks or templates have to be used as before, but drawings need not necessarily be vertical.



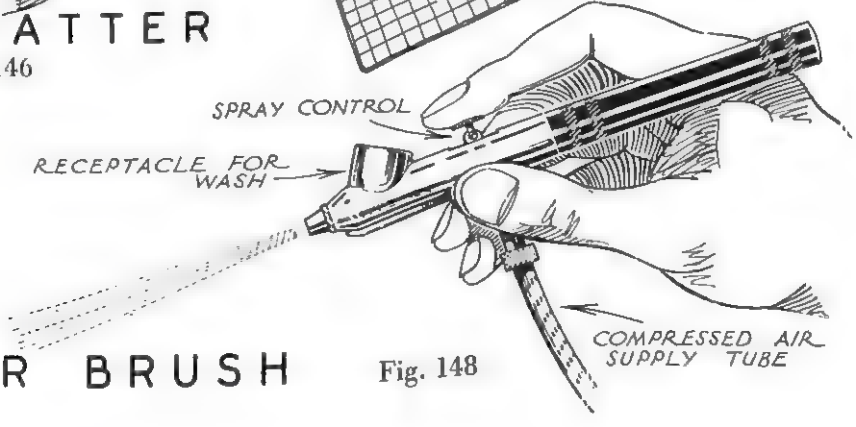
SPRAY

Fig. 147



SPATTER

Fig. 146



AIR BRUSH

Fig. 148

CHAPTER IX

FREEHAND SKETCHES

The ability to make freehand sketches simply and quickly is of value to anyone; to architects, planners and everybody connected with the design and construction of buildings it is well-nigh indispensable. By means of sketches ideas and explanations can be far more rapidly conveyed than by words, and can, moreover, be more easily understood. No study of architecture and building can be undertaken without the making of intelligible sketches and the technique should therefore be one of the first things to be practised by the student, who will thereby subsequently save much time and labour.

The word "sketch" has many meanings. It is often used to mean rather smudgy, woolly drawings of an impressionistic nature. These have their proper place, but what is meant here is the clear, diagrammatic drawing made with the fewest possible lines and with no attempt to give a photographic effect.

Training in freehand sketching consists of (1) training the "eye", including the "mind's eye" or imagination, and (2) training the "hand" to express what is seen. The two things proceed simultaneously, but it is no use trying to train the hand if the vision is defective.

Technique

In looking at a building or any object, or in imagining it, it must be analysed into (1) shapes bounded by lines, and (2) axes.

(1) Whatever the sketch is to be—a plan, elevation, section, perspective—it must be resolved into its essential simple geometrical shapes, as seen in one plane.

(2) At the same time, any prominent axial lines (lines of symmetry) must be noted. Almost every subject, whether strictly symmetrical or not, has axial lines of some kind or, failing these, outstanding horizontal or vertical lines. Such lines are the first to be drawn, and using them as a basis the various geometrical figures are built up in correct proportion. When the skeleton of lines is complete, the most important features are sketched in and after these, the next important, and so on, to details as may be necessary. All the drawing is done in the first instance by lines; shades and shadows being added only if essential for the purposes of the sketch. By practice it will be found that a great deal can be expressed by lines, straight, curved, squiggly, and by dots, making further elaboration unnecessary.

Preliminary Exercises

The majority of sketches are best made in pencil. The pencil should be fairly soft, well sharpened, and firm under pressure on smooth paper.

Exercise 1—*Straight Lines*

Fig. 149 illustrates examples which should be practised. All lines must be drawn freehand and must be as straight and even in quality as possible. A slight wobble is not serious, but there is no virtue in trying to make an irregular line.

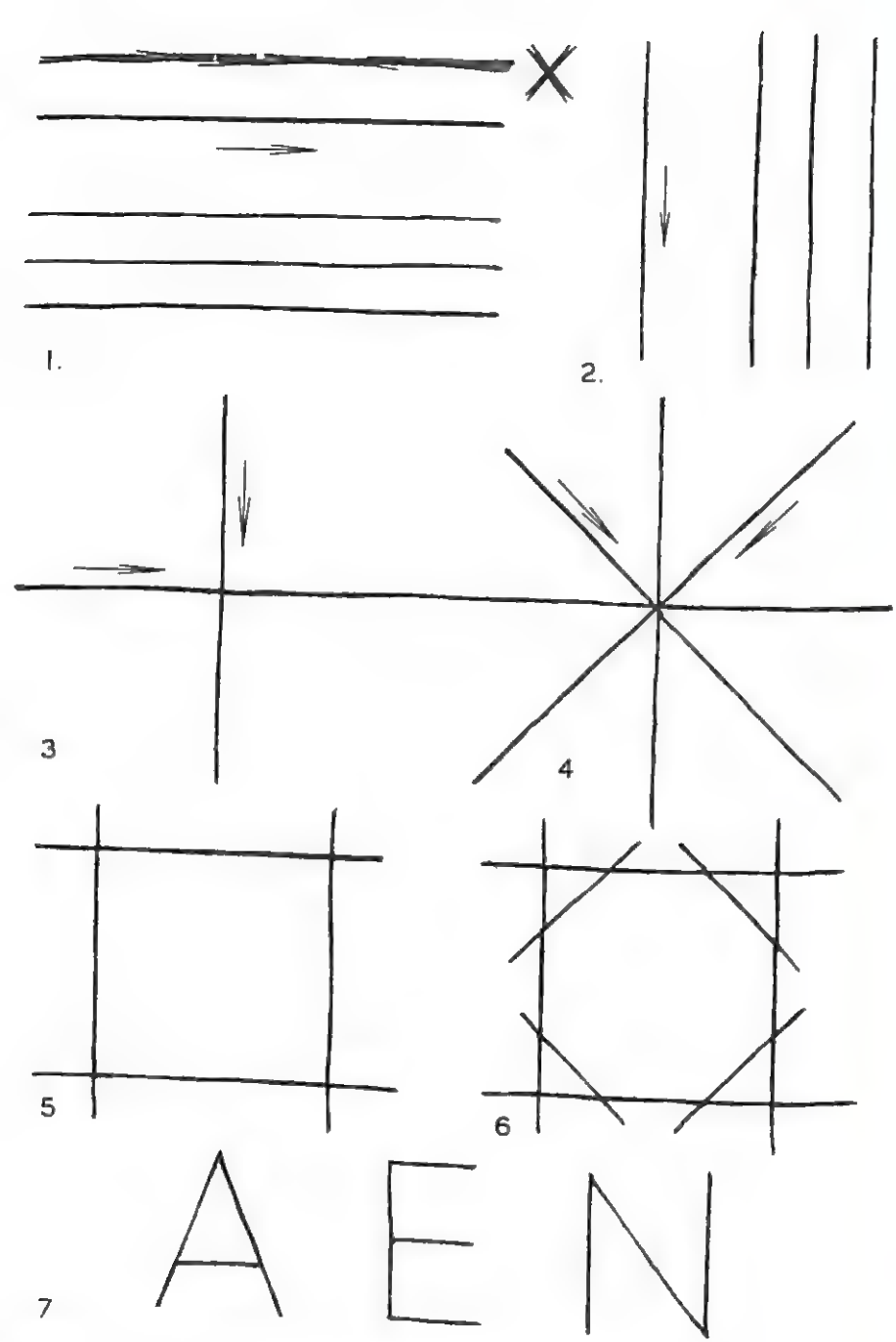
(1) Horizontal lines drawn from left to right. To help in keeping them horizontal try making them equidistant from the edge of the paper (use paper with straight square edges, it is easier). A line $1\frac{1}{2}$" long is good enough at first; longer lines can always be made up of a succession of short lines. After a single line has been drawn satisfactorily, draw several horizontal lines parallel and equally spaced to one another—all, of course, by eye.
(2) Vertical lines drawn from top to bottom. Keep parallel to the side of the paper.
(3) Lines at right-angles. Draw either the horizontal of the vertical first, then the other to cross at right-angles through a determined point.
(4) Lines at 45 degrees. First draw lines at 45 degrees to pass in both directions through the intersection of lines at right-angles drawn as in (3). Then try drawing 45 degree lines by themselves. Check for accuracy afterwards with set-square.
(5) Square. Drawn with horizontal and vertical lines, starting with different sides first. Check for accuracy.
(6) Octagon. Drawn by adding 45 degree lines to square.
(7) Lettering, patterns, etc., composed of straight lines.

If it is found that the vertical lines persistently slant in one direction, try to correct the tendency by deliberately making such lines lean a little (as you see them) to the other side. If the difficulty is serious vision is defective.

Exercise 2—*Curved Lines*

Fig. 150 illustrates examples.

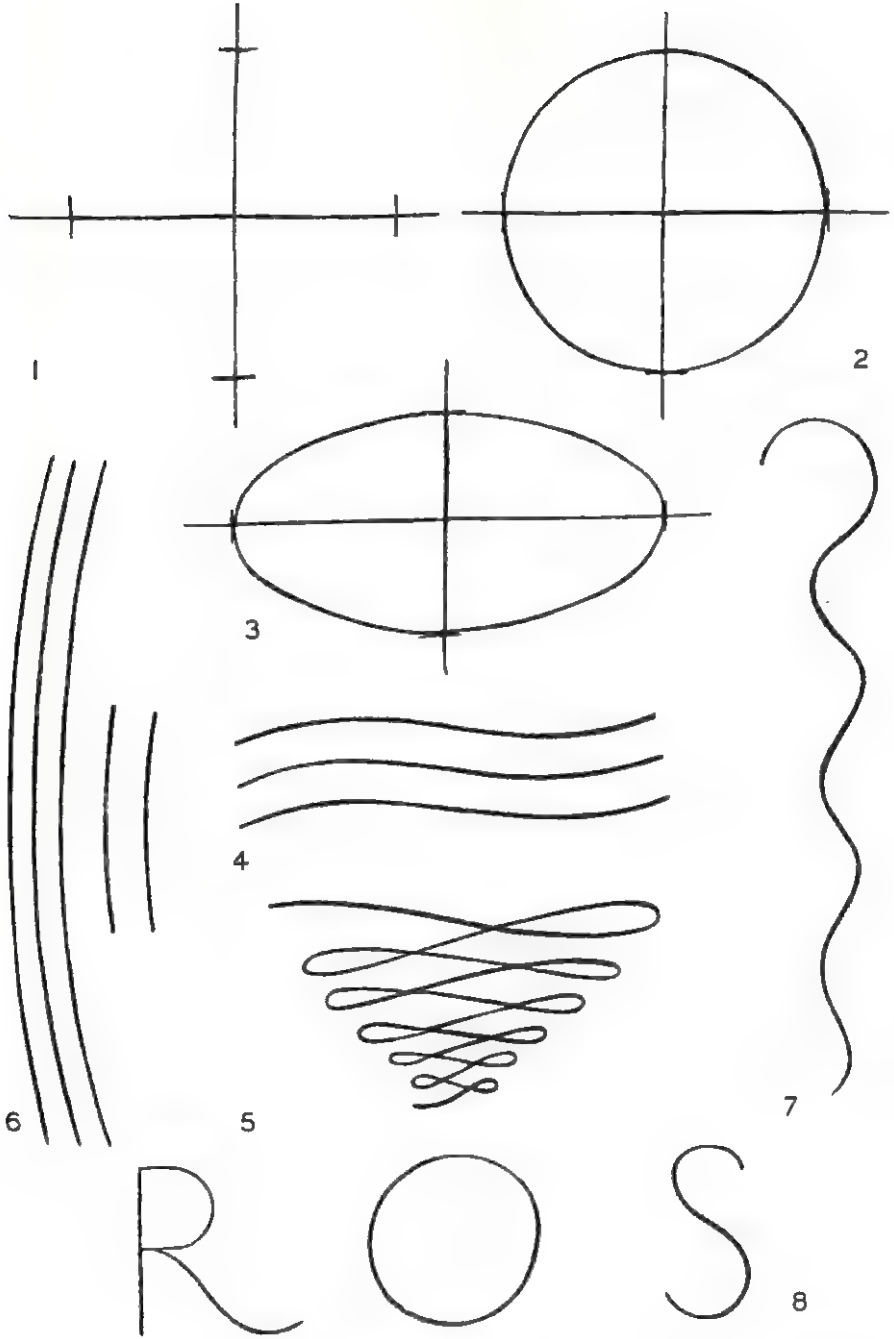
(1) and (2) Circle. Easiest way is to draw two lines lightly at right-angles, mark on them points equally spaced from the intersection and draw the curve to pass through the points. The fullness of the curve will be assisted if the points are marked by short cross lines.
(3) Ellipse. Similar procedure to circle.
(4) Line of double curvature. Draw them to various sizes.
(5) Continuous diminishing looped line. Practice for smoothness and regularity.
(6) Flat arcs.
(7) Free curves.
(8) Lettering or simple pattern composed of curved or curved and straight lines.



FREEHAND DRAWING

ELEMENTARY EXERCISES *STRAIGHT LINES*

Fig. 149



FREEHAND DRAWING
ELEMENTARY EXERCISES *CURVED LINES*

Fig. 150

When the above exercises have been practised and present no difficulty, then any building or object can be sketched provided the eye has been trained to pick out the essential lines.

Fig. 151 shows examples of the setting-up and finished sketches of a number of plans. (1) and (2) the plan of the house in Fig. 105. This consists of straight lines mainly at right-angles, as do most building plans. Note the "filling-in" of walls; centre lines through openings, arrows at entrances, etc., all conventions to help legibility. (3) Plans of a Greek temple. Note drawing of line and marking of centres of columns in setting-up. (4) Bramante's plan for St. Peter's Church, Rome. Note the stages in the setting-up. In such an axial plan only one-quarter needs to be fully completed. (5) Irregular shape. Note representation of water in pool and of grass by short dashes.

Fig. 152 shows examples of the setting-up and indication of elevations. (1) is the elevation of the house in Fig. 105, showing the main lines. (2) is a smaller thumb-nail sketch of the same subject. (3) and (4) St. Paul's, London. Note the setting-up of the main lines. The first line drawn is the ground line, then the vertical axes, then the main horizontal divisions. This sequence is suitable for most elevations. Note also the rapid suggestion of detail in the completed half of the sketch. (5) Sketch of a detail. Note how main shape and outline are established first, and the thickening of some lines to suggest form.

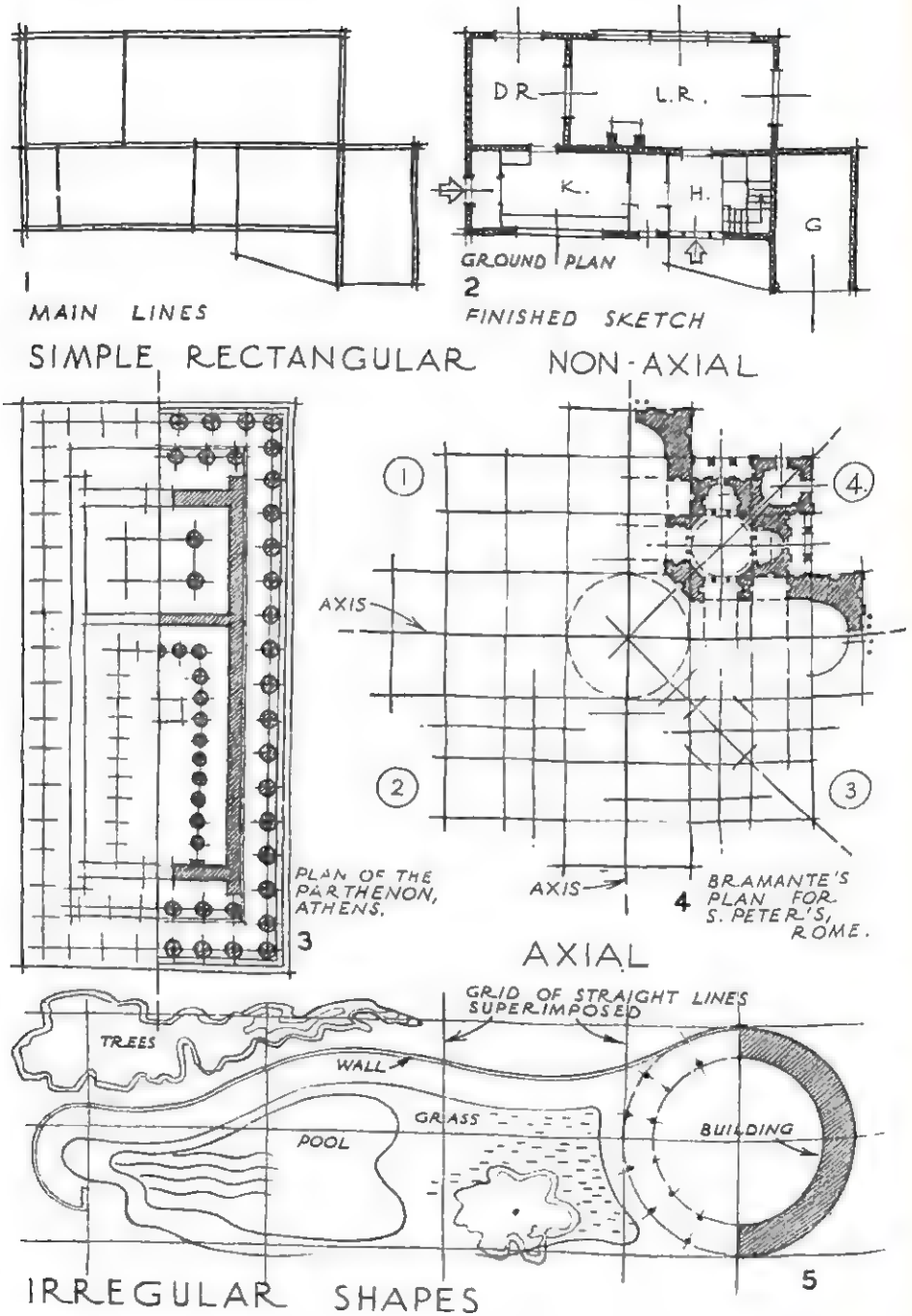
For most uses the above type of sketch is adequate, but a greater degree of finish can be given. By adding conventional shadows, by eye, the third dimension can be brought out more strongly, and the sketch passes from the diagrammatic to the semi-pictorial. By the addition of surroundings and an indication of material, texture, etc., attractive pictorial sketches can be made if necessary. All this is excellent practice for the development of a personal style of free sketching in which the preliminary stages are done automatically and the initial setting-up on paper is omitted, Fig. 158.

Sketch Perspective

Perspective or metric sketches can be made on exactly the same lines as described above for plans and elevations. There is no essential difference in technique. Good practice is obtained by sketching solids in various projections.

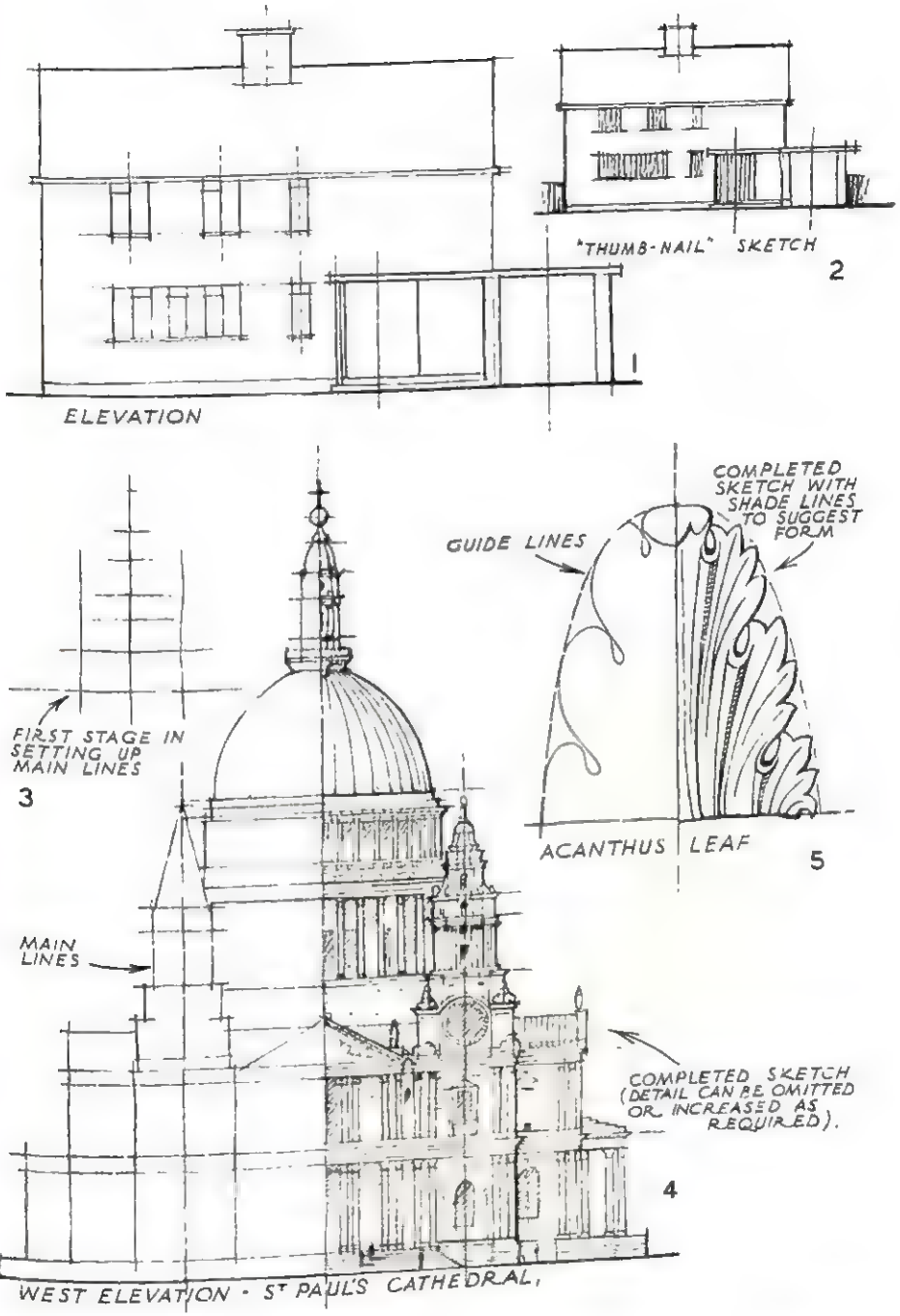
Fig. 154 illustrates certain points in connection with perspectives. The most important is that an eye-level (horizontal) on which must lie the vanishing points (see Chapter VII) must

be established by trial or judgment to avoid distortion, although the construction need only be lightly indicated. It is a common mistake to have the vanishing points at different levels. The drawing of curved or more complex forms is made easier by enclosing them in "boxes" or frameworks of straight lines.



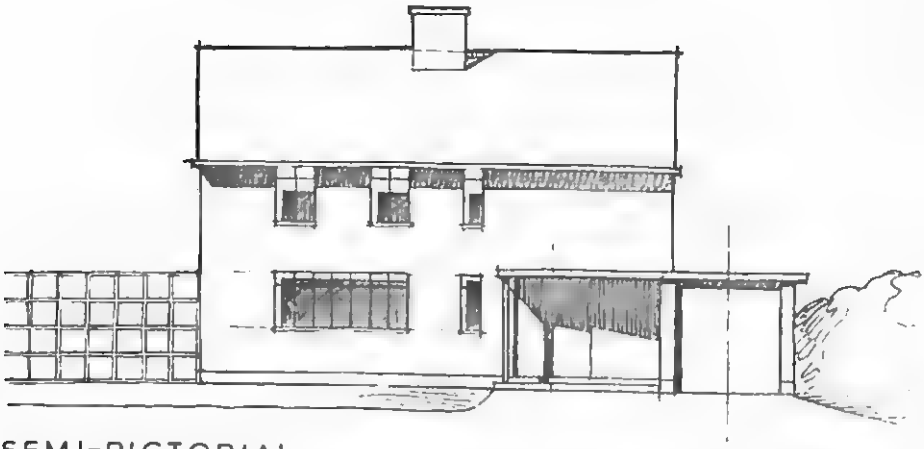
FREEHAND DRAWING
SETTING UP AND INDICATION OF PLANS

Fig. 151



FREEHAND DRAWING
SETTING UP AND INDICATION OF ELEVATIONS

Fig. 152

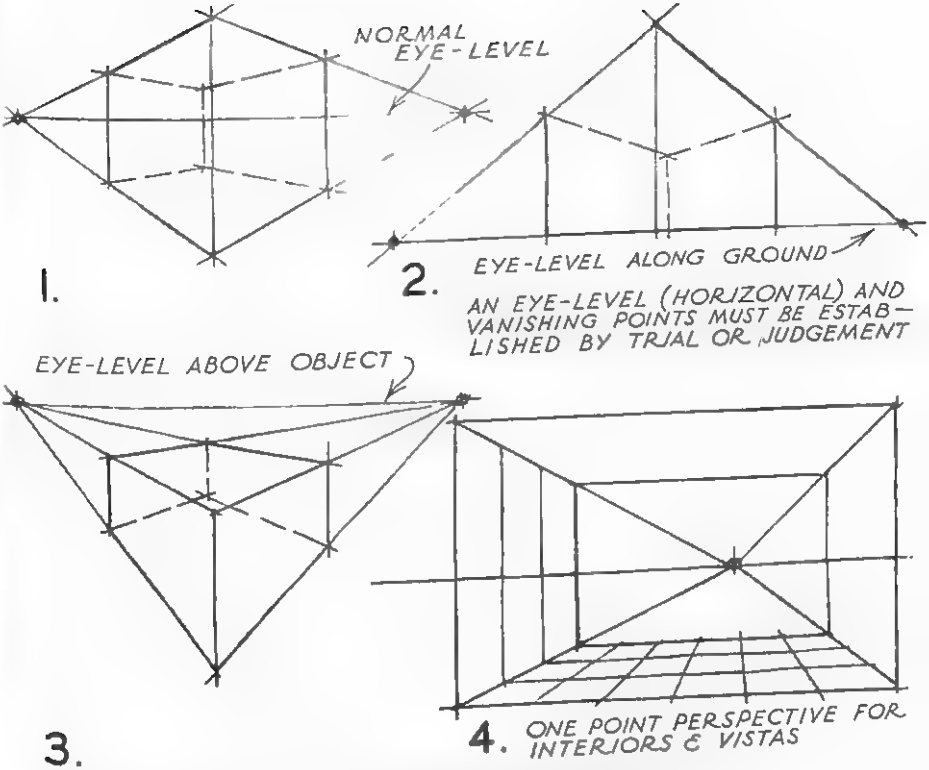


SEMI-PICTORIAL

PICTORIAL

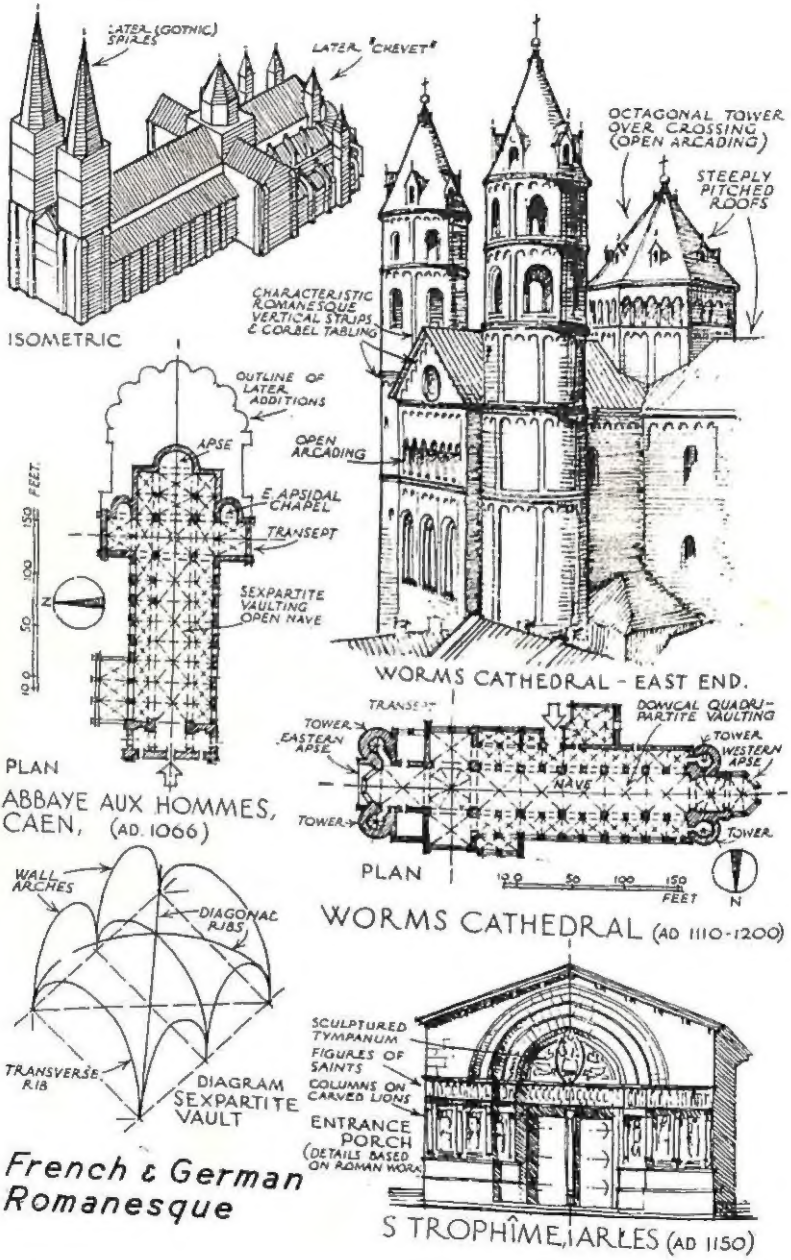
FREEHAND DRAWING
SKETCHES OF ELEVATIONS

Fig. 153

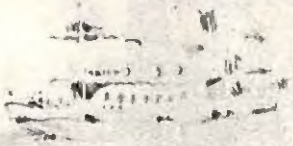


SKETCH PERSPECTIVE

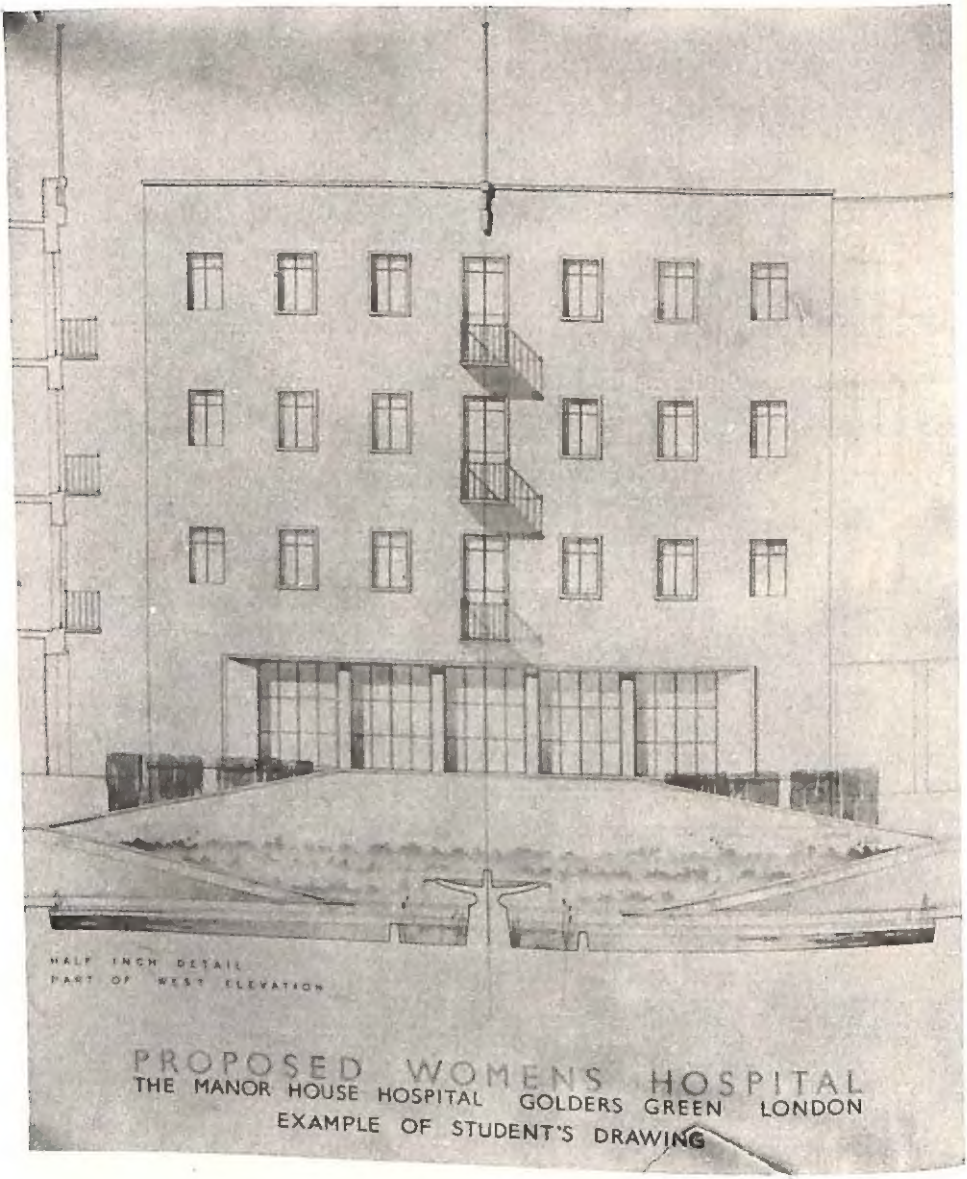
Fig. 154



French & German Romanesque



VIEW FROM LAKE EUGENE



PROPOSED WOMENS HOSPITAL
THE MANOR HOUSE HOSPITAL GOLDERS GREEN LONDON
EXAMPLE OF STUDENT'S DRAWING